MANUFACTURE OF DISINFECTANTS AND ANTISEPTICS

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MANUFACTURE OF

Disinfectants & Antiseptics

With tried Recipes and Practical Hints, with
details of every Process simply explained
and the Secret of the Art
fully exposed

BY

M. N. MITTER, M.Sc.

AUTHOR OF DENTAL PREPARATIONS
AND ELECTRO-PLATING IN PRACTICE.

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47, HOSPITAL STREET
KOTTAIYUR—623 10
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CONTENTS

PAGE.

CHAPTER I.

PROSPECTS AHEAD.

Bacilli in Action 1
How to Combat Bacilli 3
Possibility of Manufacturing Disinfectants, etc. 4

CHAPTER II.

CLASSIFICATION OF DISINFECTANTS.

Volatile, in the Form of Gas or Vapour 7
Solid or Liquid Disinfectants 8

CHAPTER III.

MATERIALS USED IN DISINFECTANTS.

Carbolic Acid 10
Creosote Oil 11
Rosin 11
Rosin Spirit 13
Naphthalene and Nitronaphthalene 13
Bleaching Powder 14
Caustic Soda 14
Making of Caustic Lye 16
Soft Soap 18
Hard Soap 21
Formalin 21
Permanganate of potash 22
Caustic potash 22

PAGE.

Making Caustic Potash Lye 22
Acetic Acid 23
Borax 23
Benzoin 23
Rosin Oil and Rosin Spirit 24
Cresols or Cresylic Acids and Higher Homologues 25
Pine Oil 25
Sulphonated Oils 25

CHAPTER IV.

LIST OF APPLIANCES.

Balance 29
Furnace 29
Boiling Kettle 30
Beaume's Hydrometer 31

CHAPTER V.

MANUFACTURE OF CARBOLIC ACID AND CREOSOTE.

Distillation of Coal Tar 32
Stages of Distillation 33
Treatment of Carbolic Oil 36

CHAPTER VI.

LIQUID DISINFECTANTS.

Principle of Manufacture 38
Recipes (17) 40
Spray for Theatre (2) 49

PAGE.

CHAPTER VII.

SPECIAL TYPE OF DISINFECTING FLUID.

Lysol Type (3) 51
Creosote Oil Disinfectant (3) 53
Pine Oil or Rosin Oil Disinfectant (7) 54
Cresol Disinfectant 58
White Disinfectant 59
Disinfectants of High Carbolic Co-efficients 59
Para Chlorophenol 61
Tri-Chlorophenol 61
Naphthols 63
Bromophenols 64
Recipes (3) 65

CHAPTER VIII.

SOLID DISINFECTANTS.

Manufacture of Naphthalene 67
Naphthalene Balls 69
Other Solid Disinfectants (7) 70
Disinfecting Tablets 73
Cresol Tablets (2) 74
Cesspool Deodorant & Disinfectant (2) 74
Solid Block Disinfectant (3) 76

CHAPTER IX.

ELECTROLYTIC CHLORINE & BLEACHING POWDER.

Manufacture of Electrolytic Chlorine 78
General Principles 78
Detailed Process 79

PAGE.
Electrolytic Bleaching Solution 82
Bleaching Powder (Chloride of Lime) 84
Bleaching Powder as a Disinfectant 87

CHAPTER X.

SICKROOM DISINFECTANTS.

Recipes (3) 88
Fumigation of Rooms after Infectious Diseases 89
Preparation of Lysols 90
Test for Purity 91
Assaying 92

CHAPTER XI.

STANDARDISATION OF DISINFECTANTS.

Solids 94
Liquids 96
Rideal Walker Test 98
Lancet Method 99
Technique 100
A Typical Test 102

CHAPTER XII.

INSECTICIDES.

Insect Powder (3) 104
Dalmatian Insect Powder 106
Mosquito Destroyers 106
Mosquito Pastilles (2) 106
Mosquito Sprays (2) 108
Mosquito Soap 108
Mosquito Oil (2) 109
Mosquito Powder (2) 109
Mosquito Repellant 110

PAGE.
Eradicating Beetles or Cockroaches 110
Cockroach Eradicating Powder (2) 111
Rat Poisons (5) 112
Phosphorus Rat Paste 114
Non-poisonous Rat Destroyer 114
Mouse Exterminator 115
Lice Killer (2) 115
Adhesive Fly Papers (2) 116
Poisonous Fly Papers (3) 117
Non-poisonous Fly Papers (2) 118
Fly Poison (2) 118
Fly Powder 119
Fly Sprays (2) 119
Bed Sprays (2) 119
Bed Bug Exterminators (3) 120
Bed Bug Killer (3) 121
Bed Bug Killing Powder 122
Bed Bug Spray (2) 122
Ant Destroyer (4) 123
Insect Sprays (9) 124
Destruction of Fleas on Dogs, Cattle and Horses 127
Moth Destroyers (3) 128
White Ant Killer 128
White Ant-Proofing Oil 129

CHAPTER XIII.

DISINFECTANT SOAPS.

Disinfectant Fluids vs. Soap 130
Advantages of Disinfectant Soap 131
Chief Disinfectants 132
Carbolic Soaps 132
Cresol Soaps 134
PAGE.
Iodine Soap 135
Sulphur Soaps 136
Wood Tar Soaps 137
Coal Tar Soaps 139
Tar Sulphur Soaps 139
Mercury Soaps 141

CHAPTER XIV.

AGRICULTURAL INSECTICIDES AND FUNGICIDES.

Animal Parasites 142
Vegetable Parasites 143
Microbe Parasites 143
Destroying Parasites 144
Agricultural Insecticides 144
Bordeaux Mixtures 146
Burgundy Mixture 147
Bordeaux or Burgundy Mixture with Rosin 147
Self-Boiled Lime-Sulphur 147
Lime-Sulphur Insecticide Washes 148
Wettable Sulphur Spray 149
Lime Wash for Fruit Trees 149
Formalin 149
Ammoniacal Copper Fungicide 150
2 p.c. Copper Sulphate Solution 151
Sulphur 151
Potassium Sulphide 151
Corrosive Sublimate 152
Condy's Fluid 152
Potassium Permanganate 153
Non-poisonous Fruit Spray 153
Orange Worm Spray 153
Lime Sulphur Spray 153
Kerosene Emulsion (2) 154

PAGE.

CHAPTER XV.

ANTISEPTICS.

Preparation of Boro-glyceride 156
Calcium and Sodium glyceroborates 157
Iodoform 159
Preserving Animal Skins (2) 160
Preserving Stuffed Animals (3) 161
Preserving Books 161

CHAPTER XVI.

STERILISATION OF DRINKING WATER

Method of Sterilisation 162
Sand Filters 163
Sterilisation by Boiling 164
Purification by Oxidising Agents 164
Sterilisation with Hypochloride & Chlorine 165
Sterilisation of Water by Ultra Violet Rays 166

PAGE.

CHAPTER XVII.

MEDICATED GAUZES.

Carbolic Gauze, 10 p.c. 169
Salicylic Gauze 10 p.c. 169
Boric Acid Gauze 10 p.c. 170
Thymol Gauze 2 p.c. 170
Iodised Gauze 10 p.c. 171
Iodoform Gauze, 10 p.c. 171

CHAPTER XVIII.

MEDICATED COTTON.

Absorbent Cotton Wool 173
Iodised Cotton 176
Salicylated Cotton 177
Boric Cotton 178
Cotton with Boric Acid, 10 p.c. 179
Iodoform Cotton 179
Cotton with Iodoform 10 p.c. 180
Glycerinated Cotton 180
Haemostatic Cotton 180
Sal Alembroth Cotton 181
Ammoniacal Cotton 181

CHAPTER I.

PROSPECTS AHEAD.

THE microscope has laid bare before our vision a host of microbes, bacteria, bacilli, germs, etc., which so long escaped our unaided sight. They infest the earth, air and water and settle to multiply wherever there are conditions congenial to their propagation and growth.

Not all of the bacteria are positively inimical to animal life—in fact a good number of them are very friendly towards human system—but there are many bacilli which are sedulously mischievous to life and horribly active in setting up micro-organisms in their neighbourhood particularly at the time of epidemics.

BACILLI IN ACTION.

These bacteria are so widely distributed in nature that there is hardly a place where they do not occur in some form or other. Not to speak of thickly populated cities and towns where the inhabitants are forced by circumstances to live in congested quarters and in ill-ventilated and insect-infested houses; even in far-off villages enjoying an abundance of wholesome light and fresh air various infectious bacteria are silently at their grim work at all seasons. These bacilli establish themselves in surroundings most agreeable to their growth and continue to breed there and spread out in diverse directions. Some of them thrive most on the dead tissues of animals, some on stagnant water, some on foulsome filth and dirty refuse matter, some on putrefying and fermenting organisms, etc., etc. They make their entry through various agencies and carriers, *viz.*, air, water, animate and inanimate objects, into human body and upset the whole system. It is well known how flies, mosquitoes and insects carry infection from house to house. A train of symptoms of a definite character, in fact a disease, is at once set up which may be a passing phase in life or may leave a permanent effect on the system, if not ending fatally in spite of all assistance rendered by the medical sciences.

HOW TO COMBAT BACILLI.

There are three ways open for combating these disease-carrying bacteria, *first* by eradicating them altogether by destroying the conditions under which the organisms live and multiply; *secondly,* by setting up conditions which will interfere with or altogether prevent their development; *thirdly,* by finding out means to prevent their entry into the animal body and thus to stamp out diseases.

The first belongs to the province of sanitation and hygiene, the teachings of which consist in scrupulous personal cleanliness and salutary surrounding. But as the latter is beyond the control of individual members of the society, too much reliance cannot be placed on the first measure as being a step for the prevention of diseases.

This leads us to think seriously of the second measure suggested above for removing diseases. We begin to understand the utility of disinfectants, such as disinfecting fluids, electrolytic chlorine, bleaching powder, naphthalene, etc. These substances acting upon bacteria and protozoa penetrate through the envelope of the organism and destroy its life.

It is evident, therefore, that when the breeding ground of the bacilli can be located definitely, the disinfectants can be applied with expectations of success. But in cases where the bacilli migrate from quarters which an individual may not be cognisant of, the only possible way left to thwart diseases is to adopt the third measure suggested for checking the spread of the harmful bacteria. This can be done by using antiseptics such as, iodoform, boro-glyceride, medicated cotton and gauzes, etc., as precautions against the attack of diseases.

POSSIBILITY OF MANUFACTURING DISINFECTANTS, ETC.

As a matter of fact, disinfectants and antiseptics have come to be reckoned as essential factors in civilization. These have been found to successfully counteract, check and kill the disease-carrying germs and have therefore come into wide use among all sections of the people; and, with the advance of hygienic science and dissemination of knowledge about sanitation far and wide, their popularity is bound to go up. Already a number of disinfectants are prepared in the country but their production is hardly able to meet the increasing demand in the country. There is sufficient scope in the line and those who take up the manufacture of disinfectants and antiseptics as a career for them will find the line offering various avenues of expansion and ramifications.

CHAPTER II.

CLASSIFICATION OF DISINFECTANTS.

DISINFECTANTS are mainly intended to absorb, neutralise, or destroy putrescent effluvia, miasma or specific contagia, and thus remove the causes of infection. Their number is extremely large and nearly every group of chemical substances includes members capable of injuring micro-organisms. In practice, however, only a small number of chemicals come under consideration, it being necessary to exclude those which act only in a high state of concentration, as well as those which unduly spoil the materials to be disinfected.

The principal disinfectants are chlorine, bromine, iodine, the so-called chlorides of lime and soda, chloride of zinc, ozone, carbolic acid, creosote, the alkaline manganates and permanganates, charcoal, the fumes of nitric, nitrous, and sulphurous acids, heat and ventilation.

Of these the last two are the most efficient and easily applied. The clothing, bedding, etc., of patients labouring under contagious diseases may be effectually disinfected by exposure to a temperature a little higher than that of boiling water for about an hour.

According to Dr. Wynter Blyth these may be divided into two great classes: (1) gaseous, and (2) solid or liquid. These again may be sub-divided as follows:—

I. VOLATILE, IN THE FORM OF GAS OR VAPOUR.

1. Substances which, like the halogens, appear to form substitution compounds, *e.g.*, chlorine, bromine and iodine.

2. Substances which probably combine chemically, and thus destroy contagion, *e.g.*, sulphurous acid, nitrous acid, and fumes of other acids.

3. Oxidising substances, such as, pure air, oxygen, ozone.

4. The volatile oils, etc. which are feeble disinfectants, *e.g.*, camphor, oil of hops, oil of rosemary, oil of chamomile, oil of eucalyptus, oil of citronella.

II. SOLID OR LIQUID DISINFECTANTS.

1. The chlorides of different metals, earths, or bases: chlorides of lime (bleaching powder), chlorides of sodium and potassium, chlorides of iron, copper, manganese, zinc, aluminium, mercury and in fact, all soluble chlorides.

2. All soluble sulphates, especially sulphates of iron and aluminium.

3. All soluble sulphites.

4. Some acetates, as acetate of iron.

5. Some nitrates, such as the nitrates of potash and soda.

6. Certain agents which appear to arrest putrefaction or condense certain gases, etc. without either destruction or oxidation, *e.g.*, carbolic acid, creosote (tar acids), charcoal, and also heat sufficient to dry organic substances, but not to char them.

7. Preservative liquids and solutions. Many of these act by coagulating the albumen of organic bodies, *e.g.*, antiseptics, alcohol, solution of corrosive sublimate, solution of common salt, solution of saltpetre.

8. Destructive agents which do not act truly by disinfection, but by destruction, *e.g.*, a dry heat of 200°—400°F, the strong undiluted acids and alkalies.

9. Agents which act in many ways, partly by condensing gases, partly by absorbing moisture, and partly by a peculiar action on organic matter analogous to tannin, *e.g.*, dry earths, clays.

10. The electrolytic chlorine and bleaching solution.

11. The natural and artificial compounds of aluminium.

CHAPTER III.

MATERIALS USED IN DISINFECTANTS.

A LARGE number of chemicals is required for manufacturing disinfectants. The chief uses and properties of some of them follow:—

CARBOLIC ACID.

Carbolic acid or phenol is the most important material used in the manufacture of disinfecting fluids, antiseptics and germicides. It is one of the constituents of coal tar, from which it is extracted by fractional distillation. It comes into commerce in two forms: (1) liquid and (2) crystalline solid. The former variety being cheap is generally used in the preparation of disinfectants. It is a dark oily liquid containing cresol, xylenol, cumenol, durenol, besides neutral tar oils. The crystalline variety being pure melts at 42°C but the presence of even a trace of water causes the whole mass to liquefy. It boils at 184°C and can be distilled unchanged. As carbolic acid is a violent poison with a penetrating odour, it should not be worked by hand. The liquid carbolic acid is sold in the market in drums.

CREOSOTE OIL.

Creosote or tar oil is another important ingredient employed in the manufacture of disinfectants. Like carbolic acid it is also a constituent of coal tar. The oil however contains cresols, and higher phenols, naphthol, and a liquid paraffin, which have but little value and are not separated. Besides its application in the preparation of disinfectants, creosote oil is used in preserving timber and railway sleepers. As creosote contains a small amount of naphthalene, the disinfectants prepared with this ingredient do not readily dissolve in water. But good results are obtained by storing the prepared substance for a long time. It generally comes into market in drums.

ROSIN.

Common rosin or colophony finds a wide application in the preparation of disinfecting fluids. The high detergent property it possesses, ready solubility and cheapness make it an indispensable article in these preparations.

Rosin, as it may be known, is the solid residue obtained during the distillation of turpentine oil from crude turpentine. It is brittle and transparent, its colour greatly varying in shade according to the quality of the product. There are three grades of rosin in the market, e.g., *virgin, yellow dip,* and *hard. Virgin rosin* is made from the first turpentine that exudes after the tree is boxed. It is of a very light yellow or amber colour. The greater part of the crude turpentine furnishes *yellow dip*. The *hard* variety is made from the scrapings of the tree after the turpentine has become too thick to run into the box; it is very dark, being nearly black. The *yellow* variety is generally used in the preparation of disinfecting fluids. It is also used as a constituent of laundry soaps, as an addition to cheap varnishes, as a flux in soldering and brazing metals, in pharmacy, and as an adulterant of fats, waxes, and mineral oils. The rosin used in these preparations must be in the form of powder.

ROSIN SPIRIT.

Rosin spirit is also required in large quantities in the manufacture of certain types of disinfectants. It is a constituent of rosin from which it is extracted with rectified or methylated spirit. It resembles oil of turpentine for which it is sometimes substituted. It is mainly used in dissolving the soap added or formed in course of the preparation of disinfecting fluids, whereby making it readily miscible in water producing a milky fluid.

NAPHTHALANE & NITRO-NAPHTHALENE.

Naphthalene is employed in the preparation of solid disinfectants and insecticides. It forms shining white plate-like crystals, melting at 79°C and boiling at 218°C. It has a peculiar penetrating odour, and is much used instead of camphor in protecting woollen goods and furs against the ravages of moths.

Nitro-naphthalene is formed by the direct nitration of naphthalene. It crystallises in yellow prisms, melts at 61°C, boils without decomposition and yields higher nitro-naphthalenes upon further nitration.

BLEACHING POWDER.

Bleaching powder or chloride of lime has come into large use among the makers of powder disinfectants and germicides. It is cheap and possesses a very good disinfectant property. It is a yellowish white substance, which should be perfectly dry and free from lumps. On exposure to the air, it absorbs moisture and carbon dioxide, giving off chlorine, and hypochlorous acid, the evolution of which has a good germicidal effect.

When freshly prepared it contains some 33 per cent of available chlorine. But on storage, especially in hot, damp climates, it deteriorates rapidly; market samples are sometimes as low as 20 per cent. of available chlorine. When using bleaching powder, it should be as fresh as possible. It comes into commerce in air-tight drums.

CAUSTIC SODA.

One of the most important ingredients in preparing disinfectant fluids is the caustic soda. Formerly the caustic soda was manufactured by treating soda ash with lime water. But this method is now obsolete as cheap caustic soda of reliable quality may be procured cheaply.

Caustic soda comes into the market in four different forms: (1) sticks, (2) flakes, (3) blocks in casks, and (4) solution. The caustic sticks are however rarely used in these preparations on account of their high prices. Caustic liquors are not also taken into credit for containing too much impurities. Flakes and blocks are in use.

Commercial caustic soda is a creamy or white mass, having a slightly fibrous structure. It is very hygroscopic, readily absorbing water from the air and passes into a highly caustic liquor. It also readily absorbs carbonic acid from the air, passing into carbonate so that it is not desirable that caustic soda should be left exposed too much to the air.

Caustic soda flakes are sold in the market in a variety of grades:—

Grade.		Per cent of caustic soda.
60°	..	77.42
70°	..	90.32
72°	..	92.90
74°	..	95.48

Grade.	Per cent of caustic soda.
76°	98.06
77°	99.35
77.5°	100.00

The figures indicating the grade have a significance. The degrees represent the percentage of sodium oxide present in the alkali plus 1 per cent. The highest grade, containing as it does more available caustic soda and less impurities, is much more advantageous to use.

Since caustic soda is required in the manufacture of disinfectants in the form of solution of definite strength, the process of making the lye is given below:—

MAKING OF CAUSTIC LYE.

Lyes of caustic soda are prepared by dissolving in water the solid caustic hydroxides. The commercial caustic soda is usually supplied in large drums which require to be broken open before the caustic, they contain, can be dissolved. This caustic is dissolved in iron tanks with a suitable quantity of water. The correct way of doing this is to suspend the solid caustic at the top of the tank just underneath the surface of the water used to dissolve it; then the lye, as it is formed, being heavier than the surrounding water, sinks to the bottom, so that the solid caustic is, by reason of the currents thus set up, always coming in contact with fresh water or unsaturated lye, and consequently becomes dissolved readily. This may be carried out by placing a perforated iron plate just under the surface of the water or liquor in the tanks. The solid caustic may be thrown on to it.

Caustic-soda lyes should not be kept too long exposed to air, as they tend to absorb carbon dioxide and be transformed into carbonate of soda, the alkaline strength being thereby reduced. It is better to prepare the lye freshly whenever required.

In preparing the lye of a given strength the caustic soda is added to water little at a time. The hydrometer is put into the solution and the mark to which the hydrometer sinks gives the strength of the lye. If greater strength is to be attained, more soda is to be added till the correct reading is obtained. If the strength is too high, dilute the lye with water;

SOFT SOAP.

Soft soap is used in the preparation of special variety of disinfectants. It is an amber-coloured to reddish-brown material of the consistency of butter. It is more soluble in water than ordinary soaps and possesses greater scouring properties. The alkali used in making this soap is caustic potash.

Linseed oil is mainly used for its cheapness in making soft soap. It is readily saponified yielding a transparent amber-coloured soap with a pleasant odour. Cotton seed oil and castor oil are also employed for the purpose.

For small manufacturers it is better to use ready-made goods; but large scale manufacturers can prepare it in their own factory more economically. A process of making soft soap is as follows:

Cottonseed oil	5 pounds.
Caustic potash (commercial)	1 pound.
Water	sufficient to produce lye of 20°Be.

Procedure:—First prepare the caustic potash lye and then allow to cool to normal temperature. Now reduce 1/3rd of the whole stock of lye to 10 °Be in a separate vessel, another 1/3rd. of the stock to 15°Be and keep the remaining portion at its full strength.

Place the whole of the cotton seed oil in a kettle of sufficient capacity. Heat it by fire. Stir occasionally to melt it. Commence the saponification by adding the 10°Be lye, little by little, taking care that all the lye combines before fresh lye is added. Keep the stirrer in hand and agitate the mass all the time.

Presently the oil would begin to saponify. The saponification commences when the emulsion forms. Thereupon stir it well, otherwise it would begin to swell and rise in the kettle.

As soon as the weakest lye has been added, pour the second lye, by degrees, taking care that all the lye combines before fresh lye is added. Finally add the strongest lye in the same manner until the saponification is complete.

The loss of water due to evaporation should be made good by adding a reasonable quantity of water now and then. The mass should always remain in thin condition.

If a certain quantity of oil floats on the surface of the paste, it indicates that the lye has grown concentrated owing to loss of water and a small quantity of water should be added, by degrees, to combine it with the saponified mass. The homogeneity of soap would be re-established and combination perfected in 3 to 5 minutes. More water should not be added than is actually needed. Also the heat should be reduced, because at the temperature near the boiling point the concentrated lyes have little affinity for fatty substances. Should the soap show a tendency to open, water is required until it boils in a smooth paste.

In case the soap floats on the surface, it must be crutched and fire withdrawn.

In making soft soap care should be taken that the heat in the beginning of the process should be gentle, and gradually raised and kept at 170° to 190°F. After the strongest lye has been added and the paste has become homogeneous and is about to acquire butter-like consistency the heat should be lowered and allowed to remain very gentle to the end.

The fire should not extend over the mass of the kettle, otherwise carbonisation occurs.

The boiling should go on quietly, until a sample taken out and cooled on a glass plate, shows the proper butter-like consistency and brightness of appearance.

When the soap is finished, run it into frames.

HARD SOAP.

Hard soap is also sometimes used in the preparation of disinfectants. A process of manufacturing this class of soap follows:—

Tallow or cotton seed oil	5	pounds.
Caustic soda	11	ounces.
Water, enough to make lye of 20°Be.		

PROCEDURE:—Same as above.

N. B. The subject of soap-making is too extensive to be dealt with in this book. For detailed description of the process consult a book on the manufacture of soap.

FORMALIN.

Formalin finds a very considerable application as a disinfectant. It is derived from formaldehyde gas obtained by the oxidation of methyl alcohol, a product of the distillation of wood. Formaldehyde has a pungent smell, and powerful antiseptic properties. It is placed on the market in the form of a 40 per cent. aqueous solution, known as formalin.

PERMANGANATE OF POTASH.

Permanganate of potash is a powerful oxidising agent, decomposing organic matter even in the cold. Owing to this property it acts as an energetic and rapid disinfectant (Condy's fluid); its action is instantaneous especially in the presence of an acid. A weak solution of this compound is generally used in the purification of drinking water.

CAUSTIC POTASH.

Caustic potash closely resembles caustic soda in its main properties, and is used in the following grades:—

70 to 75 p.c., 75 to 80 p.c., 80 to 85 p.c.

It is slightly more hygroscopic than caustic soda. It should be exposed as little as possible to the air or it would be oxidised.

MAKING CAUSTIC POTASH LYE.

Caustic potash lye is made exactly in the same way as soda lye as already explained.

ACETIC ACID.

Acetic acid has a very sour taste and pungent smell, burns the skin, and is poisonous. It is used as a solvent. Vinegar is simply diluted acetic acid.

BORAX.

Borax has often been suggested in preparing some special types of disinfectants. It forms large, colourless, monoclinic prisms. It is chemically known as borate of sodium. It is soluble in 12 to 15 parts of cold water, and in 2 parts of hot water, and also in 4 to 5 parts of glycerine, but insoluble in alcohol.

BENZOIN.

Benzoin is an aromatic substance largely used in removing foul odour. It is a kind of gum-resin soluble in water. It is a forest product, and obtained by incisions made in the bark of *Styrax Benzoin* a moderate-sized tree found in large number in Sumatra and Java. A few days after making the incisions a yellowish latex begins to exude, and this is allowed to continue for a period of 3 months. It is then sufficiently hardened and picked off. It comes in the market in lumps and in the form of tincture, of which the former variety is generally used in disinfecting purposes.

ROSIN OIL AND ROSIN SPIRIT.

Rosin oil and rosin spirit are now extensively used for making disinfectants and lubricating grease. These two important products of rosin are obtained by destructive distillation of rosin, placed in a large iron still, capable of holding 50—70 barrels of rosin, and heated by direct fire. The still is connected with a suitable copper condenser and the operation takes place about twenty four hours. Rosin spirit forms the first distillate and is a pale yellow oil. It boils between 70°—250°C. and consists of a complex mixture of hydrocarbons and oxygenated bodies, and somewhat resembles turpentine, for which it is sometimes substituted. Refined rosin spirit is a colourless, light, volatile liquid of unpleasant odour. Its specific gravity varies from 0·876-0·883. On exposure to the air it evaporates, but a portion oxidises to a resinous solid, in the same manner, but to a lesser extent, as turpentine.

Rosin oil is the distillate obtained between 250°—300°C. It probably consists of a mixture of abietic acid, phenols, and complex hydrocarbons, boiling above 300°C. It is used in the preparation of high class disinfecting fluid.

CRESOLS OR CRESYLIC ACIDS.

Cresols or cresylic acids are the residual liquid obtained after the crystallisation of carbolic acid. These are composed of *m*-, *p*-, and *o*- acids. Of these meta acid is liquid whereas ortho and para acids are solids. The liquid meta cresol is generally used. The advantage of using *m*-cresol (cresylic acid) is that it is much less soluble and much less poisonous to man than free phenol, and at the same time has a higher germicidal value. It is now largely used in making disinfecting fluids and lysols of high carbolic coefficient.

PINE OIL.

This is a liquid of similar character from *Pinus punilis*. It has identical properties of rosin oil and is largely used in the preparation of disinfecting fluid of high carbolic coefficient.

SUPHONATED OILS.

Sulphonated castor oil is largely used in making disinfecting fluid for their greater dispersing properties than soaps. This is simply oil emulsified with sulphuric acid. To prepare sulphonated castor oil, it is run into wooden tank, preferably lined with sheet lead, and provided with cocks at different heights to facilitate the running off of wash liquors, etc.; the sulphuric acid is then gradually run in with continual agitation, either by hand-worked paddles or by a mechanical agitator. The proportion of acid to be used varies from 15 to 30 per cent of the weight of oil used according to the season of the year. In winter 20 to 30 parts, and in summer 14 to 20 parts of concentrated sulphuric acid are the most suitable quantity for every 100 parts of castor oil.

After standing 14 to 24 hours, a solution of common salt is introduced, and the whole well agitated with the object of removing excess of free sulphuric acid not converted into compound acids, glycerol, glycerosulphuric acid, and such like substances soluble in water, without removing the soluble compound sulphuric acids formed, these being much less soluble in brine than in plain water. If during this washing the liquor becomes much heated, considerable loss is brought about, because dilute hydrochloric acid is formed which rapidly hydrolyses the compound acids present. Plain water is, therefore, sometimes used for a first washing, and brine or better still, sodium sulphate solution for subsequent use.

A certain amount of soda or ammonia is then run into the washed oil and well admixed, so as to neutralise part (but usually not all) of the free acidity; and finally enough water is added to bring down the percentage of oleoginous matter present to the required extent, 50 or even less in some cases.

In some cases ammonia is used in addition to caustic soda in neutralising the oil. Three-fourths of the amount of caustic soda required to complete the neutralisation is first added and then the neutralisation is completed with a one to one liquid ammonia and water solution.

The ultimate product is consequently a sort of emulsion of undecomposed fatty matter and free acids disseminated through an aqueous solution of the soaps formed by the action of the alkali added to the free fatty acids and compound sulphuric acids formed.

If properly prepared, sulphonated castor oil can be diluted with water without allowing any oily drops to separate until after standing some considerable time; and may be dissolved in ammonia solution and diluted with water without becoming seriously turbid through separation of oil, etc. If much precipitation is visible solid fatty glycerides are present, due to adulteration of the original castor oil with rape or cotton seed oil.

In the practical manufacture of the sulphonated castor oil it is generally considered indispensable to prevent the temperature from rising materially above 35° or at most 40°C., otherwise secondary reactions take place, leading to the evolution of sulphurous acid, and production of inferior products.

There are numerous other methods and varieties of sulphonation but this is one of the simplest and easiest to handle.

CHAPTER IV.

LIST OF APPLIANCES.

A LARGE number of appliances are required for the preparation of disinfectants. The most important of them are described below:—

BALANCE.

Balance is an absolute necessity, as the proper proportion of the materials cannot be ascertained without it. There are many types of balances of which the most common one consists of a beam or lever.

FURNACE.

This is by far the most important requisite in the manufacture of disinfecting fluid. The size of the furnace would depend upon the size of the boiling pan and the quantity of stock to the treated in a single batch. A raised platform is constructed in the middle to serve as the top of the furnace. There is, however, an opening at the bottom for the passage of air. Iron gratings are placed just above this opening for proper airing. The ash pit is left just below the gratings. Either coal or fuel is fed into the fire, this being placed over the gratings and set fire to.

Besides the above type of furnace, which is suitable for large scale manufacture, smaller type of ovens may be made for easy regulation of the heat. In this case a rectangular brick-built oven may be constructed, say, 2 or 3 cubits high with one side completely open. A small portable oven may be made separately. The size of this is just enough to be pushed inside or withdrawn from the brick-built oven over which the pan is placed. The portable oven can be put inside the brick-work at the time of boiling and can be taken out when no further boiling is desired.

BOILING KETTLE.

Pans are required for boiling fluid disinfectants. These are made of several pieces of wrought iron plates riveted together firmly. It somewhat resembles in shape the cauldrons of the confectioners but is much bigger and deeper, the depth being more than the diameter. Usually its capacity should be four or five times the charge to be treated at a time. This allowance is made as the fluid is liable to froth up tremendously during boiling and would be otherwise spilt for nothing and may end in disaster.

In most modern factories the ordinary boiling pans are replaced by kettles, which are provided with coils all through the volume of the kettle. Steam from the boilers is made to circulate through the coils.

BEAUME'S HYDROMETER.

This is an instrument to ascertain the density or specific gravity of liquids. It is made of glass and has a bulb at the lower part. The specific gravity is indicated by the depth to which the hydrometer sinks in the liquid, the zero of the scale marking the depth to which it sinks in pure water. A considerable quantity of liquid in the jar is necessary to float a hydrometer fairly. Fill the jar with the liquid to be tested. If the liquid is too warm, it should be cooled to normal temperature before its density is tested.

CHAPTER V.

MANUFACTURE OF CARBOLIC ACID AND CREOSOTE.

CARBOLIC acid and creosote are largely employed in the manufacture of various kinds of disinfectants. These are obtained along with benzine, toluene, anthracene oil, etc., during the distillation of coal tar.

DISTILLATION OF COAL TAR.

The distillation of tar is usually carried out in a cast iron still, consisting of an upright cylinder, of nearly equal height and diameter, provided with a dome-shaped top and a concave bottom, the whole being firmly set in brickwork and heated by fire grates. These stills are set vertically in furnaces so that the flames play under the bottoms, and about half way up the height, through side flues in the brick setting. But sometimes the bottom of the still is protected from direct contact with the flame by a brick arch. The still is also furnished with a steam coil through which superheated steam is blown towards the end of the process. Prior to distillation the tar is allowed to stand undisturbed for a long period to separate out the water in it, for the presence of water is likely to produce froth during distillation thus causing enormous troubles.

The still is connected with a condenser consisting of a cast iron or lead worm, placed in a tank of water. A steam pipe is arranged to warm the water, if necessary.

STAGES OF DISTILLATION.

While the still is yet hot from the previous distillation, the tar is run in. The manhole and valves of the still are closed, and heat is applied until the contents begin to froth. The overflow pipe is then opened, and any ammoniacal liquor which separates out is drawn off. The heating is continued carefully until the still-head gets warm, and puffs off vapour, and finally drops of liquid begin to come from the condenser.

At this stage the fire is moderated in order to prevent boiling over. A closed receiver is placed at the end of the condenser, and the distillation is continued very slowly, until the temperature reaches 105°C, when as a rule, the first receiver is changed. The distillate is commonly separated in the following order:

First runnings: The first runnings or first light oil contain water, ammonium salts, volatile oils and a little quantity of heavier oils carried over mechanically. After this distillate has run for some time it nearly ceases, although the fire is now increased.

Second Light Oil: When the temperature within the still reaches above 110°C the liquid again begins to flow from the condenser. This is known to manufacturers as " Second light oil." It is collected in another receiver until the temperature of the tar reaches 210°C or until the specific gravity of the distillate becomes 1·00. This can be easily understood from the fact that a drop of oil will neither sink nor rise, if put in water.

This light oil contains benzene, toluene, xylene, with some thiophene, phenols, pyridine bases, heavy oils, etc., which are separated from each other by fractional distillation. We need not go in detail with the process for our purpse.

Carbolic Oil: The carbolic oil is distilled until the temperature of the tar reaches 240°C or until a few drops of the distillate cooled on an iron plate show crystals of naphthalene.

Creosote Oil: After the separation of carbolic oil, the temperature of the still is further increased but not above 270°C. The creosote oil distils over and is collected in another receiver. It also furnishes naphthalene, which crystallises out on cooling and is thereby separated by centrifuging and pressing. This distillate is the least valuable and is often not purified further.

Anthracene Oil: Anthracene oil or "green oil" collected above 270°C, contains anthracene, the most valuable constituent of the tar. The water in the condenser is now brought to the boiling point. Superheated steam is injected into the hot tar in the still to assist in carrying over the heavy vapours. The process is generally stopped when the distillate becomes "gummy."

Pitch: The residue in the still is known as the pitch. It is a viscous mass while hot and is taken out through a tap after cooling a few hours.

TREATMENT OF CARBOLIC OIL.

The carbolic oil as obtained from the condenser contains phenols and naphthalene. The latter is sparingly soluble in the heavy oils, the warm water in the condenser preventing its crystallisation in the worm.

To separate naphthalene from phenols the oil is allowed to stand for some time, when large quantities of naphthalene crystallise out and are separated by centrifuging and pressing.

The mother liquor from which the naphthalene has been separated, contains 30-40 per cent. of phenol. This is separated by fractional extraction with a caustic soda lye of specific gravity 1·095, which dissolves the phenols forming sodium carbolate. The aqueous alkaline liquid is then drawn off from the oil and decomposed with sulphuric acid, whereby crude carbolic acid separates out as an oily liquid, from which the phenol crystallises on chilling.

Another method of extracting the phenol is to heat the mother liquor with a mixture of lime and sodium sulphate, sodium carbolate being formed and calcium sulphate precipitating. After the impurities have settled, the solution of phenols (tar acids) is decanted. The crude product is purified by repeated distillation in a specially constructed apparatus with zinc condensers. Crystals of phenol separate from the distillate on cooling, while the cresols remain liquid. The phenol is separated from all liquid matters by means of a centrifugal machine. By treating the alkaline solution of phenols with an insufficient quantity of sulphuric acid, the cresols are precipitated first and may be separated, the phenol being separated afterwards with more acid.

CHAPTER VI.

LIQUID DISINFECTANTS.

PRINCIPLE OF MANUFACTURE.

LIQUID disinfectants which turn milky upon the addition of water are nothing but rosin soaps dissolved in carbolic acid. In order to manufacture this type of disinfectants, the alkali is first weighed in a suitable balance and then dissolved in water so as to form a lye of definite strength. A little application of heat, however, facilitates the process. The caustic soda lye is then allowed to cool. In the meantime the rosin is heated in an iron pan and as soon as it is melted the heat is reduced by closing the oven with a plate. The lye is then slowly stirred in; when the whole of it has been added, the mass is stirred for a few minutes more.

Quantities of caustic soda of 98 % to be added to 100 parts of water to obtain lyes of particular strengths vary widely, namely 20·64 parts for 23°Be; 31·05 parts for

30°Be; 41·16 parts for 35°Be; and 43·33 parts for 36°Be.

The mixture is then heated so as to saponify the whole of the rosin in order to form what is termed "rosin soap." In order to ascertain complete saponification of rosin, a small sample is taken out from the pan. If it remains in the form of brown jelly without separation on dropping it in water the saponification is complete. This when dissolved in any of the substances, such as carbolic acid, creosote, or tar oil is converted into a high class disinfecting fluid. Occasionally vegetable oil is used in these preparations to impart the usual whiteness when the fluid is treated with water before use. Instead of caustic soda a mixture of caustic soda and potash can be advantageously used.

The tar oil, which is frequently used, contains naphthalene; hence the disinfectants prepared with tar oil do not readily dissolve in water. Ths difficulty must be obviated at all cost to ensure a good result. For this purpose the disinfectant is allowed to stand for about three months, during which period the naphthalene separates out as crystals and the fluid is decanted off.

Great care need be exercised while the saponification of the oil with the alkali takes place. The heat should be regulated very carefully so that the flame does not by any means come in contact with the surface of the oil, in which case an explosion is likely to occur endangering life and property. The sudden use of temperature may also be accompanied by swelling up of the mass and the subsequent flowing over, which must be prevented at any cost.

Here are a few reliable recipes:—

I.

Common rosin	18	pounds.
Commercial caustic soda	4	„
Crude carbolic acid (30 per cent)	7	gallons.
Water	2½	„

Procedure:—Add the soda to water and heat to dissolve, then add the rosin (powdered); and continue boiling until saponified, and all is perfectly dissolved. Take particular care that it does not boil over, as it froths much as it boils. Keep boiling showly until reduced to about 3 gallons, then pour in 4 gallons of the carbolic liquid, stir well, and let down the heat a bit, then add the remaining fluid, stir a few minutes, then run out.

II.

Ground common rosin	2	cwt.
Commercial caustic soda	50	pounds.
Water	40	gallons.
Crude creosote (Tar oil)	35	,,

PROCEDURE:—Boil the caustic soda in 15 gallons of the water to form a lye, then add the rosin, boiling until dissolved and saponified; then pour in the remaining water by degrees, and add about 20 gallons of the creosote; stir well and lessen heat. Then pour the remaining creosote in the pan and stir for a few minutes. Then cover and keep aside to cool. Finally fill in tin cans and drums.

III.

Rosin	7½	seers.
Caustic soda 98°p.c.	1¼	,,
Water to dissolve caustic soda	2	gallons.
Light creosote oil	2½	,,
Water to produce	15	,,

PROCEDURE:—First take one galvanised bucket and dissolve in it the caustic soda with the amount of water as specified above. Allow the solution to cool to the room temperature.

In the meantime put the pan over fire and place into it the rosin after breaking into small pieces. When the rosin is completely melted and giving off profuse fumes reduce the fire by covering the mouth of the oven with a thick iron plate. It is better to take down the pan upon the ground. Now slowly but continually stir into the rosin the caustic soda lye prepared as above. Stir vigorously for some time adding water if required. A jelly like mass is gradually formed. Now dissolve this jelly into the light creosote oil and set aside for some time. Lastly add the water to make up the required volume.

IV.

Coal-tar distillate (of sp. gr. exceeding 1·00)	100	parts.
Rosin	85	,,
Caustic soda lye (30°Be)	60	,,
Vegetable oil	20	,,
Water	200	,,

PROCEDURE:—Liquefy the rosin by the application of gentle heat. Pour in the vegetable oil (castor oil, til oil, coconut oil, etc.). Now raise the temperature of the mixture to about 100°C and stir in the caustic soda lye. Boil until saponified. Add water from time to time to make up the loss due to evaporation. Then make the soap solution by adding water little at a time until the whole water has been used up. Allow the solution to cool; when cold add the measured amount of creosote oil by continual stirring.

V.

Rosin spirit	74	parts.
Water	24	,,
Powdered rosin	14	,,
Soft soap	8	,,
Caustic soda 72-75 per cent.	4	,,
Light creosote oil	25	,,

PROCEDURE:—Put the caustic soda in water and boil to dissolve. Then add the rosin and continue boiling until completely dissolved, then add the soft soap, boiling down to 28 parts. When cool pour in the rosin spirit and 25 parts light creosote oil stirring thoroughly.

VI.

Crude rosin spirit	69	parts.
Water	24	,,
Powdered rosin	11	,,
Rosin oil or Pine oil	5	,,
Caustic soda 72-75 p.c.	4	,,
Soft soap	2	,,

PROCEDURE:—Dissolve the soda in the water. Then add the rosin and boil until saponified. Now boil this with the oil and soft soap. Then lower the heat, evaporate until reduced to about 35 parts, then pour in rosin spirit stirring thoroughly for a few minutes and cover until cool.

VII.

Rosin spirit	3	gallons.
Water	2½	,,
Rosin (powdered)	18	pounds.
Caustic soda	3	,,
Filtered creosote	2½	,,

PROCEDURE:—Boil the water and caustic soda until dissolved, then add the rosin and again boil until saponified. Next add half the quantity of rosin spirit, stir well, and keep on heating a little longer. Lastly pour in the remaining spirit and creosote, stir and cover

over, and let cool down before filling. This is a good non-poisonous fluid disinfectant.

VIII.

Rosin	25	seers.
Castor oil	10	,,
Caustic soda	3¾	,,
Caustic potash	1¼	,,
Water to dissolve caustic soda and potash	7½	gallons.
Light creosote oil	10	,,
Soft water to produce	35	,,

Procedure:—First take a galvanised bucket and dissolve in it the caustic soda and caustic potash in the water as specified in the recipe.

Next melt the rosin and put the castor oil into it. Continue heating. When profuse smoke is given off remove the pan from the fire and put it on the ground. Now cautiously add the alkali solution, with thorough and vigorous stirring. After mixing the alkali solution again put the pan over fire and heat. Add water from time to time. When deep brown jelly is formed remove the pan from the oven and set aside. Add the measured amount of creosote oil and water. Keep aside for a day to mature in a closed drum.

IX.

Rosin	9	℔s.
Coconut oil	1	℔.
Caustic soda	1⅖	℔s.
Water to dissolve caustic soda	1	gallon.
Light creosote oil	1½	,,
Water	2½	,,

PROCEDURE:—Proceed as directed in VIII.

X.

Rosin	10	℔s.
Caustic soda	1⅖	℔.
Water to dissolve caustic soda	1	gallon.
Light creosote oil	1½	,,
Water	2	gallons.
Carbolic acid	2½	oz.

PROCEDURE:—Proceed as directed in VIII.

XI.

Rosin	3	cwt.
Light Creosote	100	gallons.
Caustic soda 35°B.	30	,,
Water	80	,,

PROCEDURE:—Put the rosin and water in a suitable vessel and heat together until all the rosin is melted, then add the soda lye and boil until saponification is complete. Then make soap solution by dissolving it in the water adding little at a time. Lastly remove from the fire and stir in creosote.

XII.

Rosin	12	pounds.
Washing soda	12	,,
Water	2	gallons.
Light Creosote	3	,,
Rosin spirit	3	,,

PROCEDURE:—Melt the rosin; add the soda after dissolving it in the water. Boil until saponified. Now add the creosote, and finally stir in the rosin spirit, continuing stirring to a smooth emulsion. For cheaper quality add 5 gallons of water to the emulsion.

XIII.

Rosin	14	pounds.
Soda carbonate	14	,,
Water	8	,,
Light Creosote	3	,,
Rosin spirit	$\frac{3}{4}$	gallon.

PROCEDURE:—Boil the rosin and soda in the water until melted, stirring all the time, then add the creosote and finally stir in the

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rosin spirit, continuing the stirring till a smooth emulsion is obtained.

XIV.

Permanganate of Potash	4	pounds.
Creosote	60	,,

This is similar to Condy's world renowned disinfectant fluid.

XV.

Rosin	35	pounds.
Caustic soda lye 24°B	35	,,
Light Creosote	2½	gallons.
Water	5	,,

PROCEDURE:—Melt the rosin and add the creosote. Now reduce the heat and slowly stir in the caustic soda lye. Then boil to saponify, stirring well; then cool. Lastly add the water.

XVI.

Rosin	7	seers.
Caustic soda	1	seer.
Water to dissolve the caustic soda	1½	gallons.
Light creosote oil	2	,,
Water to produce	12	,,

PROCEDURE:—Proceed in the manner as directed under III.

XVII.

Rosin	5	seers.
Castor oil	2½	,,
Caustic soda	1¼	,,
Water to dissolve caustic soda	2½	gallons.
Light creosote oil	2	,,
Soft water	6	,,

PROCEDURE:—As in Recipe III.

SPRAY FOR THEATRE.

The following are formulas for a preparation suitable for disinfecting theatres:

Pine oil	2	oz.
Formalin	2	,,
Acetone	6	,,
Isopropyl alcohol, to make	20	,,

For use as a spray 1 oz. is mixed with 1 pint of water.

II.

Oil of lavender	60	c.c.
Oil of bergamot	30	,,
Oil of peppermint	5	drops.
Oil of cloves	30	,,
Benzoic acid	1·8	gm.
Alcohol, to make	300	c.c.

PROCEDURE:—Dissolve the benzoic acid in the alcohol and then add the essential oils. Use as above.

CHAPTER VII.

SPECIAL TYPE OF DISINFECTING FLUID.

WE ALL know that a disinfecting fluid is valued by its carbolic acid coefficient. A good fluid should have carbolic coefficient as high as 20; but this number cannot be attained by the mere addition of creosote oil. It requires the use of higher phenol homologues such as cresol, catechol and carvacrol, which are derived from tar of blast furnaces. Pine oil, rosin oil, pure carbolic acid, etc., also increase the carbolic coefficient to some extent.

The percentage of some of these to be added is as follows:—

Carbolic acid	4 to 5	per cent.
Carvacrol	1 to 2	,,
Cresol or pale cresylic acid	4 to 5	,,
Thymol	5 to 6	,,

These chemicals may be added singly or in combination with one another to increase the carbolic coefficiency.

Disinfectants with high carbolic coefficient can also be produced by other derivatives of phenol. Of this type are the disinfectants prepared by emulsifying cresylic acid or p-chlor-m-cresol with a castor oil soap. But cresylic acids and similar homologues of phenol are much less soluble and much less poisonous to man than free phenol, and at the same time have a higher germicidal value. Consequently, most of the good commercial coal tar disinfectant fluids are practically free from phenol, and are practically non-poisonous.

Recently linseed and other oils have been sulphonated, cresylic acids then mixed into the liquid, and caustic soda or potash added in sufficient amount to obtain a water-soluble neutral solution. This emulsion is said to be the best of the phenol group of disinfectants.

A few practical recipes of his type of disinfecting fluid are given below:—

LYSOL TYPE.

Cresylic acid pale	50	parts.
Sulphonated castor oil	25	,,
Caustic potash solution 25 %	15	,,

Procedure:—Add the caustic potash solution while stirring to a mixture of the other two, and adjust either with alkali or red oil (oleic acid) until a sample dissolved in alcohol is neutral to phenolphthalein. This product has a predicted phenol coefficient of 2·5.

II.

Cresylic acid or cresol	50	p.c.
Sulphonated castor oil (50 %)	24	,,
Red oil or oleic acid	7	,,
Caustic potash or soda	1	,,
Water	18	,,

PROCEDURE:—Warm the red oil and cresol. Dissolve the alkali in the water, warming if necessary. Mix these two solutions and add the sulphonated castor oil. This product will give a stable emulsion.

III.

Cresol	50	c.c.
Linseed oil	17	grams.
Oleic acid	1	grm.
Caustic potash	4·2	gram.
Distilled water to make	100	c.c.

PROCEDURE:—Heat the oil and acid to the maximum temperature of the water-bath. Add the solution of caustic potash in 25 c.c. of water, heated nearly to boiling point. Stir the mixture well and continue heating until the saponification is complete. If too much evaporation occurs, the soap may aggregate to a mass and float on the surface of the oil. This is remedied by the addition of further water. The dish is finally removed from the water-bath and allowed to cool for 5 minutes. The cresol is then dissolved in the soap without heat and the liquid adjusted to volume. This is a B. P. preparation.

CREOSOTE OIL DISINFECTANT.

I.

Light Creosote oil (25 % carbolic acid)	68	parts.
Rosin soap	30	,,
Castor oil soap	2	,,

PROCEDURE:—First prepare the rosin soap by saponifying 100 parts of rosin with 13 parts of caustic soda dissolved in 40 parts of water in the usual way. Again make the castor oil soap in the same way as rosin soap taking 25 parts of castor oil and 3¼ parts of caustic soda dissolved in 10 parts of water. Then take 30 parts of this rosin soap and 2 parts of castor oil soap and melt by the application of gentle heat. Then incorporate the liquid soap with the creosote oil.

II.

Rosin	50	parts.
Coconut oil	20	,,
Castor oil (2nd. quality)	20	,,
Caustic soda lye 36°Be	45	,,
Water	135	,,
Light creosote oil	270	,,
Kerosene oil	17	,,

PROCEDURE:—Melt the rosin in the oil mixture and saponify with the caustic alkali. Allow the soap to remain on a slow flame for some hours until the soap is clear. Dilute with hot water, remove from fire and mix the cresote and kerosene.

III.

Rosin	20	parts.
Castor oil (2nd. quality)	20	,,
Caustic soda lye 36°Be	20	,,
Water	100	,,
Light creosote oil	140	,,
Kerosene oil	6	,,

PROCEDURE:—As in (II).

PINE OIL OR ROSIN OIL DISINFECTANT.

I.

PROCEDURE:—Dissolve 5 parts caustic soda in 10 parts water and set aside to cool. Meanwhile melt 40 parts rosin over a slow fire at 80°C. Now reduce the temperature to 60°C and slowly stir in the caustic soda solution. Continue stirring for a few minutes more after the addition of the lye. Then slowly boil until the whole of rosin is saponified. During boiling add a small quantity of water from time to time to keep the soap moist. Now remove the pan from the fire and stir in 100 parts of pine oil, cautiously heated to 80°C. Continue stirring until the soap is thoroughly dissolved in the pine oil. Allow it to cool and then pour in drums. This preparation has a carbolic co-efficient of 10.

II.

PROCEDURE:—Heat castor oil 42 parts to 80°C over a slow fire and stir in 8½ parts caustic potash solution previously made by dissolving the solid caustic potash in 4 times its weight of the water. Now heat to boiling point and keep boiling until the oil is saponified. Then put out the fire and allow the soap to cool.

Now take 35 parts of this soap and dissolve it in 25 parts of hot water. Raise the temperature of the solution to about 80°C and pour into it 10 parts of rosin oil. Stir for a few minutes. Then remove the pan from the fire and add 30 parts cresylic acid by stirring. Continue stirring until the whole of the acid has been absorbed by the soap solution forming a deep brown fluid. Keep aside to cool and then pour in drums and seal.

III.

Rosin soap	30	℔s.
Light creosote oil	50	,,
Water	2	gallons.

Procedure:—To prepare rosin soap take the following in the proportion given below:—

Rosin	42	parts.
Caustic soda	6	,,
Water to dissolve caustic soda	18	,,

Melt the rosin over slow fire and stir into it the caustic soda dissolved in the water as specified in the recipe. Boil until totally saponified.

Now take 30 ℔s. of rosin soap thus prepared in a steel drum and pour into it 50 ℔s. of light creosote oil. Stir for some time, then add the water. Stir a few minutes more and then keep aside for a day.

IV.

Xylenols	20	℔s.
Water	75	,,
Soft soap	5	,,

PROCEDURE:—First prepare soft soap according to the direction given in Chapter III. Then weigh out and dissolve it in 20 ℔s. of Xylenols. Lastly add the water and stir for some time and then keep aside to mature.

This will produce carbolic coefficient 10 R. W.

V.

Castor oil, 3rd. quality	7	seers.
Caustic soda	1	seer.
Water to dissolve caustic soda	2	gallons.
Light creosote oil	4	,,
Turpentine oil	20	fl. oz.
Water	½	gallon.

PROCEDURE:—Heat the castor oil to about 100°C and slowly but cautiously stir in the caustic soda lye. Continue heating, add water from time to time to make up the evaporation. When the castor oil is totally saponified, remove the pan from the fire and stir in the creosote oil. Set aside for a day in a closed drum and then add the turpentine oil and water.

VI.

Pine oil	80	℔s.
Sulphonated castor oil	20	℔s.

Mix.

VII.

Pine oil	63	℔s.
Soft soap	29	℔s.
Water	8	℔s.

PROCEDURE:—Warm the water and dissolve the soap. Then mix the pine oil.

CRESOL DISINFECTANT.

Cresol	500	c. c.
Castor oil	300	grams
Caustic Potash (Stick)	80	„
Rectified spirit	10	c. c.
Water sufficient to produce	1,000	c. c.

PROCEDURE:—Put the potassium hydroxide in 80 c. c. of the water. When solution is about three-fourths complete, add the alcohol and stir gently until solution is effected. Add this solution to the oil which has been previously warmed to about 60°C upon water bath, and stir gently. When saponification is complete, add the cresol in small portions with stirring. Finally remove from the water bath, cool and adjust the column with water.

WHITE DISINFECTANT.

Cresylic acid	50	lbs.
Creosote oil	6	,,
Sulphonated castor oil	5	,,
Gelatin	3	,,
Water	36	,,

PROCEDURE:—Dissolve the sulphonated castor oil and gelatin in the water and gradually add to them the mixture of cresylic acid and creosote oil with vigorous agitation in small quantities at a time. Final treatment with a colloid mill may be necessary to obtain a good dispersion.

DISINFECTANTS OF HIGH CARBOLIC CO-EFFICIENTS.

A number of formulas and processes which will produce good disinfecting fluids of comparatively high carbolic coefficients have been mentioned. But the manufacturers are now-a-days called upon to increase the coefficient still further. A few chemicals have been found to possess the properties of increasing germicidal value of the disinfectants but these are not available in appreciable quantities in the finished state in the market. It therefore devolves upon the manufacturers to prepare these chemicals beforehand by starting from their mother substances, which will require, however, a good knowledge of industrial chemistry and manipulative skill.

Among the chemicals so utilised are chlorine or such inorganic salts as bleaching powder which are excellent disinfectants, but on account of their corrosive character cannot be applied indiscriminately. Further, the strength of a hypochlorite solution rapidly diminishes on keeping.

The organic chloro-compounds are superior since while they act similarly to the hypochlorites, they are far less irritant and can be preserved without decomposition in the solid state and solutions of definite concentrations can be made up easily without analytical control.

We deal briefly with the manufacture of a few of these chloro-compounds which may be of help to the manufacturers.

It is a known fact that the replacement of hydrogen by a halogin in the nucleus brings about a marked elevation in germicidal activity; unfortunately the toxicity of the phenol is raised by such replacement, although the introduction of but one halogen group causes slight decrease. The toxicity can be compensated for by the simultaneous introduction of an aliphatic group in the nucleus. Accompanying an increase in germicidal activity there is a decrease in solubility. Substitution in the para position is more effective than in the meta position whilst ortho-substitution produces but little effect.

PARA-CHLOROPHENOL.

It is soluble in spirit, ether, and fixed oils, but is practically insoluble in water. It has been used as an ointment (2 to 3 per cent. with vaseline) in the treatment of erysipelas and lupus.

TRI-CHLOROPHENOL.

Trichlorophenol has been used as a disinfectant and claimed to be 25 times stronger than carbolic acid (*Martindale*). It occurs in white needles of unpleasant odour and pungent taste, volatilises with steam.

Some suggest the use of tri-chloro meta cresol, lysocresol, as a powerful non-toxic disinfectant and this substance has been incorporated in a soap or sulphonated fat or fatty acids. P-chloro-m-cresol, which is stronger than p-chloro-p-cresol or p-chloro-o-cresol, when tested against staphylococci and chlorinated xylenols, has been the subject matter of patents. Mixed chlorophenols prepared by the action of chlorine and hypochlorites on crude phenol incorporated with absorbents form the basis of some disinfectants.

Chlorophenols may be prepared by passing dry chlorine gas into phenols kept cool by surrounding the containing vessel with ice or freezing mixture so that temperature may not mix. During the passage of chlorine the carbolic acid absorbs the gas, at first very rapidly so that care should be taken whereby the acid may not suck up into the chlorine chamber. As soon as the action stops as noticable by the smell of chlorine gas the supply of chlorine should be put down and the chlorinated phenol should be kept in stoppered bottles for use.

Owing to its relative insolubility, emulsification has to be resorted to in order to make use of its high germicidal power. Various manufactured articles of the class are in the market under different names, the preparation of a stable, fine emulsion (the finer the emulsion, the greater the germicidal power) being the secret of success or failure, provided that the halogenated tar acids used are sufficiently active. Emulsification can be brought about in many ways with fats or resin, alkali or soaps, and various oils. It is a noted fact that the emulsifying oil is not without influence on the germicidal power of the disinfectant, it being claimed that linseed oil is superior to other oils in this respect. Sulphonation of the phenols and their derivatives also yields soluble salts which are also germicidal. The introduction of aliphatic chains into the nucleus of phenols further raises the germicidal activity.

NAPHTHOLS.

Naphthols also possess higher germicidal values. *Schneider* observes that naphthols dissolved in alkaline carbonates have greater disinfectant powers than alkaline naphtholates; the former solutions contain naphthol in the free state. He states that staphylococci and typhoid germs are killed in a short time by 0.5 to 1 per cent of B-naphthol alkaline carbonate solution.

The hydronaphthols, such as tetrahydronaphthol, or tetralin, are stated to be more powerful germicides than naphthols and equivalent to the xylenols in germicidal activity.

Bechhold found the odourless and non-poisonous halogen substitution naphthols are more powerful than any disinfectant except mercuric chloride. These compounds appear to exert a markedly selective action on various organisms; thus tribromonaphthol, *providoform* and dibromo-beta-naphthol have high germicidal values on some bacillus. On the other hand monochlornaphthol exerts but little selective action, its action being uniform for all organisms.

BROMOPHENOLS.

Next to chlorophenols, the bromine derivatives of phenols possess greater germicidal values. It is found that tri-bromophenol is 46 times as active as phenol itself and penta-bromophenol is found to possess 500 times as powerful in its action as phenol itself.

Similarly the halogenated cresols are more powerful than cresol themselves.

The bromophenols are obtained by adding bromine water to phenol solution, when they fall as a white precipitate.

As the detailed methods of preparations of these compounds are too elaborate it is beyond the scope of this book. The manufacturers may refer to any text book of organic chemistry for full particulars.

A few typical formulas follow:—

I.

Rosin	10	lbs.
Sulphonated castor oil	4	lbs.
Caustic soda	1	lb.
Caustic potash	1⅛	lb.
Chlorinated cresol	1½	gallons
Chlorinated phenol	¼	lb.
Soft water	5	gallons

PROCEDURE:—First of all dissolve the caustic soda and caustic potash in 2 gallons of water. Keep aside to cool. Next melt the rosin over slow fire and mix the sulphonated oil. Reduce the fire and slowly but cautiously pour the alkali solution. Stir and heat gently until the soap is formed. Put down the fire and allow the mass to cool almost to room temperature. Then mix the chlorinated cresol and chlorinated phenol one by one. Stir and then mix the remaining 3 gallons of water. Keep in a well closed drum for a couple of days. Then fill in bottles.

II.

Rosin	5	℔s.
Linseed oil	8	℔s.
Castor oil	2	℔s.
Caustic potash	3	℔s.
Water to dissolve the caustic potash	1½	gallons
Xylenols	5	℔s.
Chlorinated carbolic acid	¼	℔.
Soft water	3 to 5	gallons

Procedure:—As in (I).

III.

Linseed oil soft soap	25	℔s.
Water	70	℔s.
Chlorinated phenol	4	oz.
Light creosote oil	8	℔s.

Procedure:—Mix with stirring.

CHAPTER VIII.

SOLID DISINFECTANTS.

AMONG the solid disinfectants one of the most important substances is the naphthalene, a constituent of coal-tar, forming over 5 per cent. of it. It has a peculiar penetrating odour, and is much used instead of camphor to protect woollen goods and furs from the attack of moths.

Other solid disinfectants are generally composed of either naphthalene or carbolic acid crystals. The substances are incorporated with soap or oil so as to form a thick mass, which is subsequently moulded to form blocks. When the disinfectants in the shape of powder are desired, the carbolic acid or creosote is simply incorporated with a large quantity of chloride of lime or calcined clay.

MANUFACTURE OF NAPHTHALENE.

For the manufacture of naphthalene, carbolic oil obtained from fractional distillation of coal tar is run into shallow tanks or pans, either from the still or after the tar acids have been extracted and allowed to become cold, when the major portion of the naphthalene crystallises out. The liquid is drawn off and the crystals are either shovelled into piles to drain or passed through a centrifuge which leaves the crystals nearly dry. In this condition it is either sent to the market as "drained creosote salts" or crude naphthalene or submitted to the refining process to obtain it in the purest form.

The process of refining naphthalene consists in freeing it from adhering phenols and other unsaturated hydrocarbons. The crude material should be in a coarse crystalline condition to allow of the proper extraction of the oil. For this purpose the crude naphthalene is melted with 5 per cent. of sulphuric acid, the acid is drawn off, and the naphthalene is distilled. Sometimes instead of being distilled, the naphthalene is sublimed by placing in a shallow iron pan heated by steam coil when the vapours given off are passed into a large chamber where they are condensed.

For recrystallising the naphthalene the substance is dissolved in petroleum spirit in enamelled iron vessels provided with a reflux condenser and heated by steam. The crystals are either centrifuged or pressed in a canvas bag and dried in air.

The naphthalene thus obtained is, practically speaking, chemically pure occurring in large crystalline plates.

NAPHTHALENE BALLS.

In order to produce naphthalene balls the purified naphthalene is carefully melted at a low heat in an ordinary melting pot and ladled into the moulds with an iron ladle. Great care must be taken in melting the substance because at a high temperature it will ignite and burn causing a great loss to manufacturers. In casting, iron and wooden moulds are generally used. These are made in two halves connected together with pins; in each half a number of hemispherical depressions are sunk in a line with a tube connecting them all together. At one end of mould is a hole drilled for pouring in the melted mass. On cooling the liquid is solidified into balls, which may be separated by breaking off the attached pipe.

OTHER SOLID DISINFECTANTS.

Many other varieties of solid disinfectants are manufactured with naphthalene as one of their principal constituents. The general procedure is to liquefy the naphthalene by the application of heat and then thoroughly incorporate with soap or oil so as to form a thick emulsion.

Sometimes the ground naphthalene is mixed together with other solid ingredients so as to form a powder, which is largely employed as sanitary powder.

A few practical recipes of solid disinfectants follow:—

I.

Naphthalene	18	parts.
Soft Soap	4	,,
Oil soluble scarlet dye		to tint.

Procedure:—Run down the naphthalene in a large pan by a little heat, adding the soap when the former liquefies; when the soap has mainly dissolved, vigorously stir to emulsify them; cool, add the colour, stirring about to make it uniform, then run out into frames or moulds and cut up into required sizes. This kind of article is intended for use in cisterns, sinks, etc., and gradually dissolve impregnating all water that passes.

II.

Chloride of lime	490	pounds.
Ground naphthalene	70	,,
Turpentine oil	1½	gallons.
Eucalyptus oil	1	pint.

PROCEDURE:—Mix the oil with the turps, then add to the two others, and pass through a sieve to mix them well.

III.

Ground soda crystals	2½	cwt.
Ground alum	½	,,
Soluble creosote	2	gallons.
Turpentine Oil	½	gallon.

PROCEDURE:—Mix the liquids, then distribute over the powdered alum and soda and pack into packets, or in tins.

IV.

Calcined clay	10	cwt.
Red ochre	30	pounds.
Soluble creosote	12	gallons.

PROCEDURE:—As in II.

V.

Calcined clay	1	ton.
Red ochre	66	pounds.
Crude carbolic acid	30	gallons.

PROCEDURE:—Make a "bay" of calcined clay as in making mortar, mixing up with the acid, after adding the red ochre.

VI.

Chloride of lime (dry)	2	pounds.
Burnt alum	1	pound.

PROCEDURE:—Mix the substances thoroughly and keep in air-tight drums. It should be used either dry or moistened with water. This is said to be Collin's celebrated disinfecting powder.

VII.

Mutton tallow	5	parts.
Powdered rosin	1	part.
Ceresine	1¾	,,
Palm oil	¼	,,

PROCEDURE:—Melt the ingredients together over a slow fire until thoroughly incorporated. Now take 5 parts of the grease so obtained and saponify it with 1 part of caustic soda dissolved in small quantity of water. Then incorporate 4 parts of cresol. Set aside to cool and cut into suitable blocks or cubes. Finally put in suitable containers.

DISINFECTING TABLETS.

The disinfecting tablets have not yet found general application notwithstanding their advantages. The oldest form of disinfecting tablets was prepared by mixing pure carbolic acid, liquefied by heat with 40 per cent of hard soap, the mass being formed into tablets when cold. These tablets however did not keep well and had to be stored in glass tubes. They melted at 107°F and gave a cloudy, but complete, solution in water, the disinfecting properties being apparently unaffected by water.

Carbolic acid "Phenostal" tablets are a combination of carbolic acid and oxalic acid, 2 parts of the former to 1 of the latter. Owing to the powerful disinfectant properties of the oxalic acid, these tablets are one and a half to two times as effective as carbolic acid of equal concentration. This phenostal has this further advantage over carbolic acid that it is less poisonous, has less caustic action, and does not precipitate protein on absorption. The tablets are coloured with a little fuchsine, and cost about twice as much as carbolic acid of equal efficiency.

CRESOL TABLETS.

Besides carbolic acid, cresol is also used in preparing tablets. One German make has the following composition:

I.

Paracresol	75 p.c.
Hard soap	15 p.c.
Talc and Bole	5 to 7·5 p.c. each

This tablet however possesses an evil smell which is only partially masked by perfumes (coumarin).

II.

Cresol tablets may also by prepared by compounding metacresol 50 parts with caustic potash 20 parts, talc 10 parts and Armenian bole 5 parts. These brown tablets have very good keeping properties, for though they are rather soft when newly made, they harden in storage. Nevertheless, they dissolve readily and are claimed to be superior to Liq. cresol soap of equal concentration.

CESSPOOL DEODORANT & DISINFECTANT.

I.

Quicklime powder	10	lbs.
Bleaching powder	2	,,
Potassium carbonate	1¼	,,

PROCEDURE:—Mix and sift thoroughly the three ingredients. Put up in air-tight metal containers. Sprinkle liberally over the excrement which it will liquefy and deodorise. The colloidal matter will be completely destroyed. Be careful not to get the compound in contact with the skin.

II.

Quick lime	9	℔s.
Ammonium chloride	6	,,
Water	1	gallon.

PROCEDURE:—Mix the quick lime with the water. This is best done by placing a pail, containing the gallon water in cold water bath before the lime is added, as a great amount of heat is evolved when the lime is added to the water. When cold, add the ammonium chloride and stir until completely dissolved. Pour off the clear solution after settling and keep in tightly closed containers. Pour a liberal amount over the excrement which it will completely liquefy and deodorise. Be careful not to get the compound in contact with the skin.

SOLID BLOCK DISINFECTANT.

I.

Tallow	44	parts.
Caustic soda lye (40°Tw)	30	,,
Soda ash	16	,,
Light creosote oil	8	,,
Water	sufficient to dissolve the soda ash.	

PROCEDURE:—Put the tallow in a capacious pan placed over an oven. When the tallow is liquefied, slowly mix the caustic soda lye, with stirring. Boil the mixture until totally saponified. Then put down the fire and allow the mass to cool a little. Next mix the light creosote oil and finally the soda ash solution. Pour the mixture in a frame and set aside for a day. Then the solid mass is taken out and cut into small cubes.

II.

Tallow	16	parts.
Rosin	16	,,
Light creosote oil	37	,,
Caustic soda lye (66°Tw).	18	,,

PROCEDURE:—Melt the tallow and rosin over slow fire and mix the creosote oil. Take down the pan from the oven and allow the mixture to cool almost to room temperature.

Then slowly pour the caustic soda lye. Stir for some time and set aside in a soap frame. In course of a day a compact block is obtained. Cut into small cubes for use.

III.

Tallow	1½ lbs.
Rosin	1½ lbs.
Light creosote oil	9 lbs.
Naphthalene powder	1 lb.
Caustic soda	1 lb.
Water	2½ lbs.

Procedure:—Melt the tallow and rosin and while hot add the caustic soda dissolved in the water. Or, melt the fat, reduce the temperature, add the creosote oil and stir in the caustic soda.

CHAPTER IX.

ELECTROLYTIC CHLORINE & BLEACHING POWDER.

WITHIN the last two decades a large industry has arisen out of the electrolysis of the alkali chlorides, whereby not only chlorine, but also valuable bleaching solutions, chlorates, and caustic alkalies are obtained.

MANUFACTURE OF ELECTROLYTIC CHLORINE.

At the present time it is stated that over half the world's supply of chlorine and chlorine products are derived from the electrolysis of alkali chlorides. A large number of successful processes have been undertaken but we will only mention in detail the Diaphragm Process, which is the earliest and the best and has still been in use with advantage in several of the largest factories of Europe and America.

General Principles.

When an electric current is passed through a salt solution, the positively charged sodium ions pass to the negative electrode (cathode), whereas the negatively charged chlorine ions pass to the positive electrode (anode). Arriving at the electrodes these charged ions give up their electrical charges, and the sodium ions become ordinary sodium, which at once reacts with the excess of water to produce caustic soda liberating hydrogen gas.

On the other hand, the chlorine ions, after giving up their negative charges at the positive pole, are liberated as chlorine gas and also remain dissolved in the liquid surrounding the anode. In very dilute solutions, and with too high electrical potentials, the water suffers electrolysis, oxygen evolving at the positive pole, and hydrogen at the negative.

DETAILED PROCESS.

The most satisfactory type of cell employed in the manufacture of electrolytic chlorine is that of Griesham. It consists of an iron box which is made to serve as the cathode. Inside this are placed six small porous cells serving as diaphragms in which are placed the anodes connecting in series, the whole being filled with saturated sodium chloride (rock salt) solution.

The walls of the small porous cells are composed of cement, sodium chloride, hydrochloric acid. In the course of use the common salt dissolves and leaves an extremely fine-pored wall, which separates the anodic from the cathodic space, and which allows the current to pass through. The anodes are made of magnetic iron oxide fused at a high temperature and poured into moulds. Such electrodes have been superior to the carbon poles previously employed, which are attacked by nascent oxygen. The small porous cells, at the same time, are separated from each other by means of iron plates going right across the main iron box and dipping nearly to the bottom. These iron plates together with the iron walls of the main box form the cathode. The porous cells surrounding the anodes are covered with lids, the chlorine escaping through a tube leading from the interior of the cell and is led away through an earthenware pipe to chlorine chamber.

Each cell is provided with a tube-shaped grid of earthenware for filling in salt, thereby keeping the solution saturated. The bath is also furnished with a lid through which the evolved hydrogen gas escapes.

As the electric current is passed through the saturated salt solution in the bath, the chlorine ion passes through the diaphragms into the anodic space and then escapes as chlorine gas into the lime chamber where it is absorbed by the lime water forming chlorine water, utilised in the manufacture of bleaching powder, hydrochlorites and liquid chlorine while the sodium ion passes from inside the diaphragm and discharges itself on the cathodic space outside, being converted into caustic soda and hydrogen. As the action proceeds, the solution becomes weaker and weaker in sodium chloride so that saturated salt solution is run in through a pipe, and the solid salt added from time to time also maintains the supply of salt to the liquid.

The chlorine which is evolved in the electrolytic process, is extremely concentrated. It is a greenish-yellow, very irritant suffocating gas. One volume of water absorbs the below-mentioned quantities of chlorine gas:—

Temperature	10°C	20°C	30°C	90°C
Vols. of chlorine	3·095	2·260	1·767	0·380

Moist chlorine is very chemically active and decomposed by sun-light.

ELECTROLYTIC BLEACHING SOLUTION.

When an electric current is passed through a solution of common salt without the intervention of a diaphragm, we get a solution of sodium hypochlorite by the interaction of the nascent chlorine evolved at the anode and the caustic soda is produced at the cathode. This solution is then run off immediately and sold as electrolytic bleaching solution.

The process was first brought to a commercially successful issue by Hermit and Kellner. It consists of electrolysing a 10 per cent neutral solution of common salt, which is kept cool by special arrangements. The best electrodes to use are made of platinum-iridium alloy because the hypochlorites formed during the reaction will rapidly attack most other substances. The main point of success depends on the application of electric current, whose "density" should be about, 1,000—1,500 amperes per square metre electrode surface.

At first the yield of hypochlorite of over 90 per cent is obtainable by the electric current employed, but on account of the reducing action of the evolved hydrogen at the cathode, this yield soon gets smaller and smaller until it becomes impossible, without the expenditure of very large amounts of electrical energy, to obtain solutions containing more than 3 per cent of available chlorine. With low current much of the hypochlorite is reduced by the nascent hydrogen evolved at the cathode to chloride, whilst at the anode the hypochlorite tends to oxidise to chlorate.

In manufacturing electrolytic bleaching liquid, various processes are invented, of which the most successful is that of Kellner's process. which consists of glass plates covered over with bands of platinum-iridium alloy. A non-conducting plate of glass has its surface penetrated by numerous holes through which fine platinum-iridium wire is drawn so that the surface of the plate looks as if it were covered with a wire net. The holes are then carefully cemented up with a non-conducting material. In some forms of apparatus the glass plates are simply wound round with platinum wire. The plates so formed are placed vertically in a stoneware trough side by side leaving only a narrow space between the successive plates. These plates slide into vertical grooves in the sides of the trough, so as to divide the cell into a number of compartments. The whole apparatus is filled with 10 per cent salt solution and an electric current is passed through the liquid by two conducting plates placed at the extreme ends of the apparatus. When the proper amount of active chlorine is attained, the liquid is run out and fresh brine solution is introduced in the apparatus.

BLEACHING POWDER (CHLORIDE OF LIME).

The demand for bleaching powder is very great in India. Moreover it makes a subsidiary industry to the manufacture of caustic soda by electrolysis. As bleaching powder is unstable and does not keep well in hot climates, it should be manufactured locally.

When moderately dry slaked lime is treated with chlorine gas in the cold, it absorbs some 35—36 per cent of chlorine to form a dry white powder, which possesses strong bleaching and disinfecting properties, and is known as "bleaching powder" or "chloride of lime." These properties arise from its power of giving off the absorbed chlorine again when treated with acids. Although commercial bleaching powder usually contains only 35—36 per cent of available "chlorine," yet a bleaching powder containing 40 or even 43·5 per cent. of available chlorine is obtained with a slight modification of the process.

For the manufacture of bleaching powder of good quality, the lime must be carefully slaked so as to form a dry powder containing about 25 per cent of water. There should be a slight excess of water over that necessary to form calcium hydroxide, because perfectly dry lime does not absorb chlorine gas at all. The lime should be as pure as possible, and is passed through a sieve before use. The chlorine gas should be cool and dry, and carefully freed from hydrochloric acid gas; it should not also contain much carbon dioxide. The presence of a little carbon dioxide, however, in electrolytic chlorine (which is very concentrated) does not matter, because carbon dioxide acts on the slaked lime much more slowly than the chlorine gas. Generally speaking, 64 parts of slaked lime yield 100 parts of 36 per cent. bleaching powder.

The absorption chambers are made of bricks, cast-iron or lead, and are usually 6½ feet in height, and have about 200 square feet of floor area per ton of powder made per week. Brick chambers are coated inside with tar to make them gas tight and to protect them from the action of chlorine. The slaked lime is sifted through screens with from 20 to 25 meshes per linear inch, as only the fine powder is suitable. This is spread in 3 or 4 inches deep on the floor, and is furrowed with a special rake in order to assist the absorption by increasing the surface. The chlorine is introduced at the top of the chamber, and settling to the bottom because of its density, is at first rapidly absorbed by the lime.

After a time the process goes on more slowly, and finally the gas enters under some pressure. The degree of absorption of chlorine is judged by the colour of the gases seen through the glass "sights" in the chamber walls. Great care must be taken so that the temperature of the chamber may not exceed 25°C. Large excess of chlorine should also be avoided, and so usually a definite amount of chlorine is led into the chamber. In order to expose a fresh surface, the lime is turned over from time to time. Finally, before allowing the workmen to enter the chamber to remove the bleaching powder, the unabsorbed chlorine must be sucked out, either by passing a stream of air or simply by injecting some finely powdered lime dust, which absorbs most of the chlorine gas. Lastly the bleaching powder, as soon as it is removed from the chamber, is packed in wooden cases for storage.

BLEACHING POWDER AS A DISINFECTANT.

A solution of bleaching powder is a very valuable disinfectant. One part of bleaching powder will, in three hours, sterilise 2,000 parts of ordinary sewage.

When mixed with boracic acid, itself a useful disinfectant, it forms a disinfectant known as "eupad," the aqueous solution of which is termed "eusol."

CHAPTER X.

SICKROOM DISINFECTANTS.

As most of the micro-organisms infesting rooms occupied by patients suffering from infections or wasting diseases are deposited on the floors, ceilings and walls, the sickrooms should be disinfected either by fumigation of such substances as burning sulphur, etc., or by means of spraying disinfectants with a sprayer. These disinfectants are prepared with essential oils. A few recipes follow:—

I.

Carbolic acid (Crystals)	2	oz.
Rectified spirit	2	,,
Oil of bergamot	20	mins.
Oil of eucalyptus	2	mins.
Oil of citronella	6	mins.

Procedure:—Dissolve all the ingredients together and then add water sufficient to produce 20 ounces. Set aside for a few days and filter through fuller's earth when it will be ready for use.

II.

Carbolic acid (Crystals)	1	oz.
Eau de cologne	1	,,
Dilute acetic acid	18	,,

PROCEDURE:—Mix the ingredients together and stir occasionally until dissolved, keep in a cool place for several days and filter.

This is specially intended for disinfection by dropping on a hot plate. It is sometimes called "carbolised toilet vinegar."

III.

Borax	1	℔.
Ground gypsum	5	℔s.
Eucalyptus oil	2	oz.

PROCEDURE:—Mix the oil with the borax and then intimately mix with gypsum. This disinfectant is in the form of powder chiefly used in driving out foul odour from sick-room.

FUMIGATION OF ROOMS AFTER INFECTIOUS DISEASES.

The room should be fumigated for 3 hours with either the fumes of sulphurous or nitrous acids. All doors and windows being closed, the sulphur is ignited by means of burnt charcoal.

PREPARATION OF LYSOLS.

Lysol is an important medicinal preparation possessing the properties of fluid disinfectants and antiseptics, for which purposes it is largely recommended by physicians. It is a type of carbolic acid disinfectant, the preparation consisting essentially in mixing in fixed proportions coaltar oils containing phenol and its homologues, with an oil such as linseed oil or rape oil, or with resin such as rosin, and by adding a base, preferably caustic potash, in sufficient amount to obtain complete saponification. As the preparation contains alcohol, its mode of manipulation must be cautiously undertaken because with a slight carelessness on the part of manufacturer some dangerous consequences may result due to inflammability of the product. The operation is conducted in presence of alcohol, which hastens saponification and helps to render the " lysols " soluble and to impart to them a suitable consistence. The proportions in the German patent are linseed oil 10 ℔s.; coal-tar oil 10 ℔s.; caustic potash 7 ℔s; alcohol 6 ℔s. Mix the linseed oil with the tar oil, add the caustic potash, then the alcohol; the mixture is heated to complete saponification in an apparatus fitted with an ascending or upright condenser so as to prevent the alcohol from escaping.

A suitable preparation according to British Pharmacopœia may be obtained by the following process:—

Cresol	500	millilitres.
Linseed oil	180	grammes.
Potassium hydroxide	42	„
Distilled water, sufficient to produce	1000	millilitres.

PROCEDURE:—Dissolve the potassium hydroxide in 250 millilitres of distilled water, add the linseed oil, and heat on a water-bath, mixing thoroughly; continue to heat until a small portion dissolves in water without the separation of oily drops, add the cresol, mix thoroughly, and add sufficient distilled water to produce the required volume.

Tests for Purity.

Since Lysol is used in washing of wounds arising from surgical operation or otherwise, it should be tested for purity in the following way before putting up for sale.

(1) Mix 5 millilitres with 95 millilitres of water; a clear solution should form, showing no opalescence on standing for three hours.

(2) Dilute 5 millilitres with 50 millilitres of neutralised alcohol (95 per cent.), and triturate with Normal sulphuric acid (49 grammes of pure sulphuric acid dissolved in distilled water making a total volume of 1 litre), using solution of alkali blue as indicator; not more than 0.3 millilitre of acid should be required.

Assaying.

According to B. P. the following method is employed for assaying Lysol:—

Weigh accurately about 250 millilitres into a separator, add 100 millilitres of ether and a slight excess of hydrochloric acid, shake vigorously, and allow to separate. Transfer the ethereal liquid to a round-bottomed flask; wash the aqueous liquid with a little ether, and add the ethereal liquid thus obtained to the contents of the flask. Remove the ether, and distil the residual liquid in steam, the flask being heated in an oil-bath at 170°C. After liquid condensed has ceased to show any opalescence, continue the distillation, until a further 250 millilitres has been collected and the liquid condensed shows not more than a faint haze with solution of bromine. Transfer the distillate to a separator, saturate it with sodium chloride, and extract with three successive quantities of 100 millilitres of ether. Remove the ether from the mixed ethereal solutions by distillation in a tared flask, heat the residual liquid in an oil-bath at 170° to remove ether and moisture, cool, and weigh the crude cresol. Distil the crude cresol through a Liebig's condenser; collect separately any water which distils, and measure it. Transfer the non-volatile residue, by means of a little ether, to a small tared dish, heat rapidly until fumes are given off, cool, and weigh. From the weight of crude cresol, as determined above, subtract the weight of water and non-volatile residue. Determine the specific gravity of the solution of cresol with soap being assayed, and of the cresol separated from it, and calculate the percentage volume in volume.

CHAPTER XI.

STANDARDISATION OF DISINFECTANTS.

SOLIDS.

CARBOLIC co-efficient or phenol content is an index of the quality of a disinfectant. A method of determining carbolic content will thus be useful here:

In the preparation of solid disinfectants, crude carbolic and cresylic acids, containing phenol, C_6H_5OH, and ortho, meta and para cresols, $C_6H_4(CH_3)OH$, together with some hydrocarbons, are mixed with an inorganic substance such as calcium carbonate, calcium sulphate, slaked lime, etc.

To determine the percentage of phenols in such a mixture a weighed amount (about 50 gms.) is extracted with ether in a Soxhlet extraction apparatus. In this way the penols and hydrocarbons are obtained in ethereal solution. If the original mixture contains free alkaline hydroxide, such as calcium hydroxide, it is necessary to acidify with sulphuric acid (1 part of acid to 1 of water) before extraction with ether, care being taken that the temperature is kept low, otherwise phenols will be lost.

The ethereal solution is then treated in a separating funnel with two successive portions, of about 20 c.c. of 20 per cent. sodium hydroxide solution. The phenols are thus converted into phenoxides which are soluble in the water, and the hydrocarbons remain dissolved in the ether.

The combined sodium hydroxide extracts are then evaporated on a water bath to about 10 c..c., the solution being first heated by immersion in hot water, well away from any flame, until the ether retained has been expelled.

The solution of the phenoxides is then transferred to a small graduated cylinder and acidified with sulphuric acid (1 : 2). The volume of the phenols liberated is read off when the mixture is quite cold. On the assumption that 1 c.c. of the mixed phenols weighs 1·05 gm.*, the percentage by weight of phenols in the original solid may be calculated. This varies, as a rule, from 10 to 20 per cent. in such preparations.

---

* Although the mixed phenols are specifically heavier than water, they will float on the solution of sodium sulphate.

In another method for determining the strength of phenols, a weighed quantity of the solid, after acidification, is distilled in steam. The phenols and hydrocarbons in the distillate are separated after extraction with ether as described above.

LIQUIDS.

Liquid disinfectants usually consist of a fraction of a coal tar distillate, rich in phenols, combined with soap and water. Rosin is also sometimes used in their manufacture. In some cases the coal tar distillate is mixed with fat, which is then saponified.

Cresols are only slightly soluble in water, but when mixed with soap give liquids which remain clear on dilution with water.

The most important test in connection with these liquid disinfectants is that known as the Rideal-Walker test, in which the actual bactericidal property of the preparation is compared with that of a solution of phenol of known concentration.

The operations involved in one method for the purely chemical analysis of such mixtures, however, are as follows:—

5 to 10 gms. of the liquid in about 100 c.c. of warm water are treated with about 50 c.c. of 10 per cent. sodium hydroxide solution. Thereby the phenols are completely converted into phenoxides, if not already present in this form. The hydrocarbons are then extracted by means of ether.

To determine the amount of these hydrocarbons, the ethereal solution is dried over anhydrous potassium carbonate and transferred to a dry, weighed flask. The ether is then distilled off, the flask and residue dried in a desiccator over sulphuric acid and weighed.

After the ether has been removed by immersing the flask in hot water, the alkaline solution containing the phenoxides, soap, etc., is neutralised by the addition of hydrochloric acid, the acid being added until a slight turbidity is produced.

About 15 gms. of solid barium hydroxide is then added to the solution, a reflux water condenser is attached, and the mixture heated on the water bath for about half an hour, with frequent shaking.

The barium salts of the acids present in the soaps, etc. which are insoluble in water, are then filtered off from the cold liquid through teased asbestos, by means of a water pump. The filtrate, which contains the phenols as barium phenoxides, is then acidified with hydrochloric acid and the phenols extracted by means of ether. The ether is evaporated off and the residue of mixed phenols weighed.

RIDEAL WALKER TEST.

That a chemical analysis of a disinfectant does not give sufficient data from which to determine its germicidal value is at once evident; for, although the activity is generally increased if we augment the quantity of the active ingredient present, we still have no method of determining which is the active substance, nor can we compare the relative value of the different active ingredients in different germicides.

Furthermore, the germicidal power of a disinfectant is greatly affected, not only by its chemical composition, but also by its physical condition—e.g., whether ionized or non-ionized, emulsified or in solution, hot or cold.

LANCET METHOD.

Of the various methods of assaying the value of a disinfectant the Lancet Method—a modification of the Rideal-Walker method is undoubtedly the easiest to conduct and it gives satisfactory valuation.

The following is a brief description of the improved technique of this test:

Materials Required for Test.

Following materials are required for test:—

Nutrient Broth. This is prepared as follows:—

Peptone	20	grams.
Liebig's Extract of Meat	20	,,
Sodium chloride	10	,,
Distilled water	1	litre.

Boil the mixture for 30 minutes, then filter and neutralise with norml caustic soda solution, using phenolphthalein as indicator. Add when quite neutral 15 c.c. of normal hydrochloric acid. This will give the broth a reaction of 1.5 per cent. The broth is then made up to the litre, filtered and sterilized. After sterilizing, broth tubes containing 5 c.c. are prepared. These tubes after plugging with sterile cotton-wool, are placed in the steam sterilizer for half an hour or so.

Standard Carbolic Acid.—A 5 per cent. (by weight) stock solution is prepared and standardised by titration with bromine water of known strength. From this solution the various working strengths are made up by diluting some comparatively large quantity such as 100 c.c. to the desired volume; this serves to eliminate the error introduced by measuring out small quantities of strong acid.

The Broth Culture.—B. typhosus, grown in the above broth and incubated for 24 hours at 37°C., provides the test culture.

TECHNIQUE.

Before commencing the test it is necessary to ascertain the carbolic acid control dilution. This is done by running a trial test with 5 dilutions of the carbolic acid only—say 1:80, 1:90, 1:100, 1:110 and 1:120. By this test one is able to ascertain the strength which allows the organisms to survive after 2½ and 5 minutes' contact, but kills in 7½ minutes.

Four suitable dilutions of the disinfectant under examination are then prepared with sterile distilled water, e.g., 1 in 1900, 1 in 2000, 1 in 2100, 1 in 2200, for a disinfectant having a co-efficient of about 20. 5 c.c. of each of these solutions and 5 c.c. of the carbolic acid control are taken in test tubes, and at intervals of 30 seconds, 0.5 c.c. of the culture is added by means of a pipette. When 2½ minutes have elapsed since culture was added, a broth tube is inoculated from each solution, using one loopful of a standard platinum loop (4 m.m. internal diameter). Broth tubes are similarly inoculated after 5, 7½ and 10 minutes' contact, and are then all incubated at 37°C. After 48 hours, the tubes are examined and the strength of the disinfectant (e.g., 1 in 2000) noted, which like carbolic acid control, permits growth after 2½ and 5 minutes, but kills in 7½ minutes and 10 minutes.

Then the Rideal-Walker Carbolic Acid Co-efficient is $\frac{\text{dilution of disinfectant}}{\text{dilution of phenol control}}$

A TYPICAL TEST.

The following example represents a typical test:—

It should be borne in mind that no table can be accepted with this or any method which does not show harmonious curve.

Dilution of Disinfectant.	Time of Exposure.	Result on culture.
1 : 500	2½ minutes.	Alive
	5 ,,	Dead
	7½ ,,	,,
	10 ,,	,,
	12½ ,,	,,
	15 ,,	,,
1 : 550	2½ ,,	Alive
	5 ,,	,,
	7½ ,,	Dead
	10 ,,	,,
	12½ ,,	,,
	15 ,,	,,
1 : 600	2½ ,,	Alive
	5 ,,	,,
	7½ ,,	,,
	10 ,,	Dead
	12½ ,,	,,
	15 ,,	,,
1 : 700	2½ ,,	Alive
	5 ,,	,,
	7½ ,,	,,
	10 ,,	,,
	12½ ,,	,,
	15 ,,	Dead
Phenol solution 1 : 100	2½ ,,	Alive
	5 ,,	,,
	7½ ,,	,,
	10 ,,	Dead
	12½ ,,	,,
	15 ,,	,,

Comparing these results it will be seen that the disinfectant, diluted 1:600, acts with the same power as a phenol solution of dilution 1 : 100. Hence the carbolic acid coefficient or germicidal value of the disinfectant is $\frac{600}{100} = 6$, i.e., 1 part of disinfectant will do the work of 6 parts of phenol.

The following shows the germicidal value (Rideal-Walker carbolic acid coefficient) of several disinfectants towards B. typhosus:—

Disinfectant.	R. W. Coefficient.
Mercuric chloride	400-3,000
Hypochlorites (calculated on available chlorine)	146·220
Iodine water	100
Potash permanganate	42
Chlorine water	28
Silver nitrate	16
Formic acid	5·7
Benzoic acid	5
Cresol or cresylic acid	3·7
Copper sulphate	2
Lactic acid	1·8
Carbolic acid	1·0
Formaldehyde	·5-·7
Boric acid	less than 0·1

CHAPTER XII.

INSECTICIDES.

THE various insects infesting the bed rooms and kitchens such as mosquitoes, flies, bugs, cockroaches, rats, lice, etc., cause infinite trouble to the householders. Various preparations, each applicable in its own case, may be made to destroy the insects or to keep them under effective control. A number of well-tried recipes follow:

INSECT POWDER.

The ordinary insect powder of commerce is made from pyrethrum carneum, pyrethrum roseum, and pyrethrum cinerariae-folium. The first two are generally ground together forming the Persian insect powder of commerce while the third is known as Dalmatin insect powder.

The powder is obtained by crushing the dried flowers of the pellitory (pyrethrum). The leaves, too, are often used. They are cultivated in the Caucasus and Japan from where the articles are exported.

The following insect-powder formulas are perfectly safe to use:—

I.

Insect powder	8	oz. av.
Powdered borax	8	,,
Oil of pennyroyal	2	fl. drachm.

PROCEDURE:—Take the ingredients in fine powder and then mix them intimately in a stone mortar; finally pass through a sieve to ensure thorough mixing.

II.

Insect powder	8	oz. av.
Borax	8	,,
Sulphur	4	,,
Oil of pennyroyal	2	fl. dr.

PROCEDURE:—As in I.

III.

Powdered white hellebore	1	pound.
Ground quassia wood	1	,,
Ground borax	7	,,
Oil of copaiba	1	fl. dr.
Rye flour	84	pounds.

PROCEDURE:—As in I. This is especially fatal to bed bugs, bettles, cockroaches, etc.

DALMATIAN INSECT POWDER.

Ground pyrethrum	80	parts.
Ground sumach	28	,,
Dry yellow ochre	4	,,

PROCEDURE:—Mix together all the substances and run through a fine sieve to break up lumps and also to keep back coarse particles of sumach; then pack.

MOSQUITO DESTROYERS.

Of the various insects usually met with in nature perhaps the most harmful is the mosquito. To destroy them many preparations are put in the market. A few reliable recipes follow:—

MOSQUITO PASTILLES.

I.

Saw Dust	10	parts.
Powdered charcoal	6	,,
Nitre	2	,,
Gum Benzoin	4	,,
Hard tolu balsam	2	,,
Insect powder	4	,,
Wheat flour	8	,,
Water		q.s.
Green colour	2	parts.

PROCEDURE:—Reduce all the ingredients separately to fine powder and pass through a sieve. Next dissolve the nitre in a small amount of water. Make a stiff mass of wheat flour with this nitre solution using more water if required. Incorporate into this mass the mixture of saw dust and charcoal powder. Add a little more water if required. Lastly mix the remaining ingredients. The stiff mass thus produced is put into a plodding machine where by means of a spiral screw, the mass is forced under great pressure through a number of holes of required diameter, so that the mass passes out of the machine in the form of a number of continuous rods or pencils. These rods are collected over a horizontal table and cut off in equal lengths. Then convert into coils by turning them with a wooden rod and expose to the sun to dry. Pack.

II.

Gum benzoin	100	parts.
Balsam of tolu	100	,,
Charcoal	200	,,
Saw dust	300	,,
Saltpetre	50	,,
Insect powder	80	,,
Wheat flour	100	,,
Water		q.s.

PROCEDURE:—As in I.

MOSQUITO SPRAYS.

I.

Oil of pennyroyal	2	parts.
Oil of sassafras	2	,,
Alcohol	4	,,

PROCEDURE:—Mix together and put in bottles for use. To drive off mosquitoes shake the bottle and spray around with a sprinkler.

II.

Cinnamon oil	1	part.
Patchouli oil	1	,,
Sandalwood oil	4	parts.
Alcohol, 70 per cent.	400	,,

PROCEDURE:—Mix the ingredients and keep in stoppered bottles. A small amount of this solution when sprinkled with an atomiser around the room will drive away mosquitoes due to the rapid evolution of gases possessing toxic action on insects.

MOSQUITO SOAP.

Hard soap	1000	parts.
Sandal wood oil	2	,,
Oil of cedar	2	,,
Oil of pennyroyal	2	,,

PROCEDURE:—Take a good quality hard soap and reduce it to powder; then mix the oils and press into cakes of desired sizes.

MOSQUITO OIL.

These oils are generally applied to the exposed parts of the body to keep off mosquitoes.

I.

Olive oil	3	parts.
Oil of pennyroyal	2	,,
Glycerine	1	part.
Ammonia	1	,,

PROCEDURE:—Mix well and keep in bottles for use.

DIRECTION FOR USE:—The mixture is well shaken and rubbed over the face and hands and other parts which are not generally covered with cloth. When using this oil over the face, care is necessary so that the eyes may not in any way come into contact with it as it is liable to produce a serious inflammation.

II.

Oil of sassafras	1	oz.
Olive oil	2	,,

PROCEDURE:—As in I.

MOSQUITO POWDER.

Eucalyptus oil	3	parts.
Talc	6	,,
Starch	42	,,

PROCEDURE:—Mix the ingredients thoroughly and keep in a closed bottle. Apply the mixture to the exposed parts of the body with a powder puff.

II.

Oil of Eucalyptus	1	oz.
Powdered Talcum	2	„
Powdered Starch	14	„

PROCEDURE:—Mix the oil of eucalyptus with the talcum and starch by means of a sprayer.

This powder is to be rubbed into the exposed parts of the body to prevent the attack of the insect.

MOSQUITO REPELLANT.

Oil of citronella	1	oz.
Spirit of camphor	1	„
Oil of cedar	½	„

PROCEDURE:—Mix in a well stoppered bottle.

ERADICATING BEETLES OR COCKROACHES.

Besides mosquitoes there are many other injurious insects, namely, beetles, etc. They can be driven away by simply sprinkling borax solution near their haunts. A most effective way to get rid of these insects is to apply the following composition:—

Mix up a quantity of freshly burned plaster of Paris with wheat flour and a little sugar, and distribute on shallow plates and place in the corners of the kitchen and pantry, where beetles frequent. Whether it interferes with their digestion or not, is difficult to ascertain, but after three or four nights' renewal of the preparation, no cockroaches will be found in the premises.

COCKROACH ERADICATING POWDER.

I.

Sodium fluoride	60	parts.
Wheat flour	20	,,
Corn starch	12	,,
Cocoa	8	,,

PROCEDURE:—Take the sodium fluoride in fine powder. Mix the ingredients thoroughly and then sift to make certain of a homogeneous product.

This powder may be dusted as a powder; but it is better to use in dough. For this purpose take a quantity of this mixture and make it into a paste with a minimum quantity of water. Now place it in new or used crown

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KOTTAIYUR—623 106

caps, allow it to dry and then lay it in roach infested places. The caps may be used over and over again.

II.

Powdered borax	8 lbs.	10	oz.
White hellebore		8	,,
Dalmatian powder		8	,,
Ground cloves		4	,,
Cayenne pepper		2	,,

Mix.

RAT POISONS.

Rats and mice spread plague germs; hence they should be destroyed whenever possible.

To effect their destruction the following preparations are generally used with advantage:—

Arsenic compound	1	oz.
Biscuit (Powdered)	1	,,
Ultramarine	10	gr.

PROCEDURE:—Mix thoroughly and put in suitable container.

II.

Oil of aniseed	2	drops.
Strychnine	1	dr.
Sugar	1	oz.
Oatmeal	½	,,
Ultramarine	10	gr.

PROCEDURE:—Mix intimately all the ingredients together and pack.

III.

Phosphorus	8	ounces.
Boiling water	1	gallon
Corn meal	10	lbs.
Butter	10	,,
Sugar	5	,,

PROCEDURE:—Melt the phosphorus in boiling water and add the corn meal; then rub up gradually and add the butter and sugar.

IV.

A tasteless and odourless rat poison may be prepared by mixing 1 oz. of barium carbonate with 8 oz. of grease. This produces intense thirst and the rats die immediately after drinking water.

V.

Strychnine	1	dr.
Sugar	1	oz.
Oatmeal	½	,,
Ultramarine	10	gr.

PROCEDURE:—Mix.

N. B.:—The packet should carry instructions directing powdered biscuit to be put down for several nights before laying down the poison. Also directions should be given on each packet to remove early the surplus poison in the early morning.

PHOSPHORUS RAT PASTE.

Phosphorus is a violent poison and should be only used at places inaccessible to children or livestock. To prepare thin pastes, 50 oz. of boiling water are run into a porcelain mortar, add 2 oz. of phosphorus which soon melt therein; 40 oz. of flour are then added whilst stirring with a wooden spatula. When the mixture is almost cold, 4 oz. of molten tallow still tepid are run in and 20 oz. of sugar. This paste may be used against rodents and injurious insects. A little glycerine preserves it longer in the air. The paste is coated with slices of toasted bread which the rats eat without suspicion.

NON-POISONOUS RAT DESTROYER.

Gypsum powder	100	parts.
Rye Flour	300	,,

Procedure:—Dry the mixture thoroughly in oven and add 1/10 part of oil of anise. Keep in air-tight containers.

MOUSE EXTERMINATOR.

Barium carbonate	100	parts.
Oatmeal	300	„
Saccharine	1	part.
Water		q. s.

PROCEDURE:—Make a stiff dough, force through a coarse sieve, and dry in an oven.

LICE KILLER.

I.

Borax	1½	ounces
Glycerine	2	„
Decoction of Cassia	30	„

PROCEDURE:—Dissolve the borax in the decoction of cassia (1 part cassia leaves in 5 parts water) and then add the glycerine. Apply once daily.

II.

Naphthalene	4	drams.
White wax	1½	„
Olive oil	6	„
Petrolatum	6	„
Oil of bergamot	10	mins.
Oil of cloves	10	„
Oil of cassia	10	„

PROCEDURE:—Melt the wax and naphthalene over a water bath and then incorporate the olive oil and petrolatum; lastly, add the essential oils before bottling. Apply once daily.

ADHESIVE FLY PAPERS.

There are different kinds of fly papers, such as (1) Adhesive fly papers, (2) Poisonous fly papers and (3) Non-poisonous fly papers. The former are prepared as follows:—

I.

Rosin	4	parts.
Raw linseed oil	1	part.
Honey	1	,,

Procedure:—Melt the rosin and oil together, and incorporate the honey. Then spread upon writing paper with a brush. This will not dry up in a long time and is so sticky that it holds fast the legs of an insect attracted to it or accidentally coming in its contact.

II.

Linseed oil	4	parts.
Castor oil	1	part.
Carbon disulphide	1	,,

Procedure:—Boil the linseed oil until it becomes stringy. Dissolve into this the castor oil and disulphide of carbon. Paint strips or sheets of parchment paper with the mixture.

POISONOUS FLY PAPERS.

I.

Sodium arsenate	8	oz.
Brown sugar	1½	lbs.
Water	1	gallin.

PROCEDURE:—Make a solution with the above ingredients. Dip unsized paper in it, dry and cut into sheets. Each sheet should have been stamped with the word "poison."

II.

Cobalt chloride	4	drams.
Brown sugar	1	ounce.
Hot water	16	ounces.

PROCEDURE:—Dissolve the cobalt chloride in water and add the sugar; saturate unsized paper in this solution, and hang up to dry and lastly stamp as poisonous.

III.

Potassium dichromate	10	oz.
Sugar	3	drams.
Oil of black pepper	2	drams.
Rectified spirit	2	oz.
Water	14	oz.

PROCEDURE:—Mix the ingredients together and let stand for several days. Then soak unsized paper with the solution and dry and finally stamp as poisonous.

NON-POISONOUS FLY PAPERS.

I.

Simple syrup	100	parts.
Honey	30	,,
Extract of quassia wood	4	,,
Oil of aniseed	a few drops.	

PROCEDURE:—First prepare the simple syrup by boiling 2 parts of sugar in 3 parts of water. Then prepare the extract of quassia by boiling 7 ℔s. of quassia with successive portions of water until exhausted. Concentrate to 1 gallon. Now mix the two. And add the other ingredients. Lastly, dip unsized brown paper in this, dry, and cut into strips.

II.

Extract of quassia	1	gallon.
Brown sugar	$\frac{3}{4}$	℔.
Glucose	1	℔.

PROCEDURE:—First prepare the extract of quassia, as stated above. Then dissolve in it the other ingredients. Now dip unsized paper in this, dry, and cut into sheets.

FLY POISON.

I.

Black pepper (powdered)	1	part.
Brown sugar	1	,,
Milk	2	parts.

Procedure:—Mix all together and place the mass thus obtained on a plate where the flies are most troublesome.

II.

A mixture of 1 part of orpiment in 100 parts of molasses, honey or moist sugar produces a most effective fly poison.

FLY POWDER.

A dark grey coloured powder is obtained by exposing metallic arsenic into the air. Mixed with sweets, it will be used to kill flies.

FLY SPRAYS.

I.

Insect powder	8	oz.
Paraffin oil	1	gallon.
Eucalyptus oil or safrol	1	oz.

Methyl salicylate, a sufficient quantity.

Procedure:—Macerate the insect-powder in the paraffin oil for 48 hours, strain and add the other ingredients. A small amount of this preparation when sprayed with an atomiser will not only kill flies but also other insects.

II.

Insect powder	8	oz.
Paraffin oil	½	gallon.

Petrol	½	gallon.
Naphthalene	1	oz.

PROCEDURE:—As in I.

BED BUG EXTERMINATORS.

There is no doubt that the liquid form is the best to use; unlike a powder, or even a paste, it will flow down a crack into remote places where bugs hide, and will prevent their escape, and it will also kill the eggs and nits. The following substances are mostly employed and are probably the best: Kerosene, turpentine, benzene, carbolic acid, corrosive sublimate solution, oil of pennyroyal, and a strong solution of soap. There are several good recipes that can be depended upon.

I.

Oil of eucalyptus	1	drachm.
Eucalyptus leaves	1	ounce.
Benzene	2	ounces.
Turpentine oil	2	„
Kerosene enough to produce	16	„

PROCEDURE:—Mix the turpentine, benzene and kerosene oil, and macerate the eucalyptus leaves in it for 24 hours; then strain and make up the measures to 16 ounces, having first added the oil of eucalyptus.

II.

According to Hirzel, dilute sulphurous acid is an excellent agent for destroying bedbugs and their eggs, as well as other noxious insects. It is sufficient to sprinkle a few drops of the acid upon the places or into the joints and holes infested by the insects, and to repeat this several times.

III.

Insect powder	15	parts.
Colocynth	15	„
Phenol	5	„
Oil of turpentine	10	„
Alcohol	100	„

Procedure:—Macerate the crude drugs in the alcohol for 8 days, express, and filter, then add the phenol and oil.

BED BUG KILLER.

I.

Kerosene oil	90	parts.
Clove oil	5	„
Cresol	1	part.
Pine oil	4	parts.

Procedure:—Mix. If possible use deodorised kerosene oil. Method of deodorising the oil appears on p. 124.

II.

Cresol	3	fl. oz.
Dichlorobenzine	13	fl. oz.

Use one pint of this mixture to 5 pints of deodorised kerosene oil (p. 124).

III.

Kerosene	9	parts.
Carbolic acid, crystal	4	,,

PROCEDURE:—Mix. Use deodorised oil (p. 124).

Use as spray in cracks and on springs.

BED BUG KILLING POWDER.

Alum, powdered	80	parts.
Boric acid, powdered	10	,,
Salicylic acid	10	,,

PROCEDURE:—Powder very finely.

BED BUG SPRAY.

The recipes as given under bed bug killers are liquid in composition. Any of them may be used as spray for the extermination of bed bugs. A few additional recipes are noted below:—

I.

Carbolic acid, crystallised	1	part.
Camphor	1	,,
Thyme oil	1½	parts.
Alcohol	56½	,,
Carbon tetrachloride	65	,,

II.

Deodorised light petroleum oil	99	parts.
Cresylic acid	1	part.

Procedure:—Mix.

ANT DESTROYER.

Sodium arsenate	115	grs.
Sugar	1	℔.
Honey	1	fl. oz.
Water	2	pints.

Procedure:—Dissolve the sodium arsenate and the sugar in the boiling water, add the honey, and when cold, pour, into shallow dishes in which are placed pieces of bread or sponge.

II.

Aloes	$\frac{1}{2}$	℔.
Potassium carbonate	1	ounce.
Creosote	1	fl. ounce
Water	1	gallon.

Procedure:—Dissolve the potassium carbonate in water and then add to the solution aloes and creosote.

III.

Tartar emetic	1	℔.
Powdered sugar	1	,,
Powdered arsenic sulphide	$\frac{1}{2}$	oz.

Procedure:—Mix.

IV.

Sugar	1	℔.
Water	1	pint.
Thallium sulphate	27	gr.
Honey	3	oz.

PROCEDURE:—Stir together and heat to a boil. Avoid vapour when boiling.

INSECT SPRAYS.

The sprays under mosquitoes and flies, (*p.* 108) are also applicable to eliminate such insects as bed bugs, spiders, etc.

Kerosene oil is often used in sprays. Deodorised oil is most suited for the purpose. To deodorise the oil, the following procedure is recommended. First of all take:—

Sodium bicarbonate	225	parts.
Water	1900	,,
Dissolve and add to Kerosene	1900	,,

Shake for 30 minutes, then set aside for one hour and again shake for 30 minutes. Set aside until separation is complete and decant.

Recipes of insect sprays follow:—

I.

Oil of pennyroyal	1	dram.
Oil of turpentine	8	oz.

Kerosene oil, sufficient to produce	1	gallon.

PROCEDURE:—Mix and put in bottles.

II.

Insect powder	8	oz.
Kerosene oil	1	gallon.
Naphthalene	1	oz.

Macerate the first two for 48 hours, strain and add naphthalene.

III.

Insect powder	8	oz.
Kerosene Deodorised (p. 124)	1	gallon.
Methyl salicylate or Eucalyptus oil or Safrol	1	oz.

Proceed as above.

IV.

Petroleum spirits	1000	c.c.
Pyrethrum extract	5	grams.
Sassafras oil	5	c.c.
Methyl salicylate	20	c.c.

PROCEDURE:—Mix.

V.

Kerosene (p. 124)	1	gallon.
Rectified turpentine oil	4	fl. oz.
Citronella oil	4	fl. oz.

Oil of wintergreen	2	fl. oz.
Eucalyptus oil	2	fl. oz.
Camphor	1	oz.
Lemon grass oil	½	fl. oz.
Carbolic acid	1	dr.

PROCEDURE:—Mix. Use with a sprayer.

VI.

Mix either a 3 per cent. solution of pyrethrum extract in a light petroleum oil or one of the aliphatic thiocyanates in the same concentration of the same solvent. These make first class insect and fly sprays and possess a higher killing power than pyrethrum with the added advantage of pleasant odour and absence of stains.

VII.

Para dichlorbenzine	100	grms.
Methyl salicylate	20	c.c.
Kerosene (p. 124)	100	c.c.

PROCEDURE:—First dissolve the para dichlorbenzine in kerosene oil and then add the methylsalicylate. The para dichlorbenzine is also simply known as dichlorbenzine.

VIII.

Pyrethrum extract	1	quart.
Gasoline	5	quarts.

Para dichlorbenzine	8 oz.
Pine oil	6 oz.
Citronella oil	1 oz.

Procedure:—Mix all together in a stoppered bottle.

IX.

Kerosene oil emulsion is the best to destroy flies, insects and bed bugs, etc. It is prepared by boiling soap, 3 parts, in water, 15 parts. To this add, gradually shaking and stirring the while, kerosene oil to produce 100 parts. The oil, of course, should be carefully warmed before being added to the soap solution. This may also be deodorised before use as explained on p. 124.

For disinfecting floor and walls the emulsion should be diluted in a strength of 1 in 20 of water.

DESTRUCTION OF FLEAS ON DOGS, CATTLE AND HORSES.

Take equal parts of beef-gall, oil of camphor, oil of pennyroyal, extract of gentian; and spirits of wine and mix.

MOTH DESTROYERS.

I.

Soak blotting paper in a mixture of equal parts of oil of camphor and spirit of turpentine, and lay the paper among the clothing in furs.

II.

Use a mixture of equal quantity of alum, cayenne pepper, oil of camphor and calcined plaster of Paris.

III.

Camphor	4	oz.
Benzoin	1	,,
Black pepper	2	,,
Cedar Saw dust	5	,,

PROCEDURE:—Mix after reducing the solids to a coarse powder.

WHITE ANT KILLER.

I.

Soda ash	10	parts.
Sodium sulphate anhydrous	20	,,
Salt, powdered	20	,,
Borax, powdered	25	,,
Tartar Emetic	25—50	,,
Sodium fluosilicate	50	,,
Kieselguhr	50	,,
Sodium fluoride	100	,,

PROCEDURE:—Mix in fine powder.

II.

Orthodichlorbenzol	24	parts.
Naphtha	35	,,
Betanaphthol	4	,,
Rosin	4	,,
Rect. spirit	7	,,

PROCEDURE:—Mix all together and keep in air-tight container.

WHITE ANT-PROOFING OIL.

Paradichlorbenzol	16	parts.
Creosote oil	25	,,
Wood tar oil	15	,,
Heavy mineral oil	44	,,

PROCEDURE:—First melt the paradichlorbenzol over slow heat and pour into the heavy mineral oil. Then add the last two ingredients.

This product may be applied to the infested areas of the wood with a paint brush, mop or spray gun. It may also be poured into the ground in a hole drilled close to the nest or colony.

CHAPTER XIII.

DISINFECTANT SOAPS.

IN SPITE of increased knowledge of disinfectants, little attention seems to have been paid by soap manufacturers to this subject. Antiseptic soaps which were introduced many years ago still find favour with the public, because little importance is still attached to their germicidal value. It is seldom that disinfectant soaps are properly tested as to their germicidal action upon specific organisms under conditions which approximate to their use in practice. Moreover there are many disinfectants which have valuable properties as such, but which can hardly be used in conjunction with soaps without scientific knowledge of the art of disinfection.

DISINFECTANT FLUIDS Vs. SOAP.

The conditions which obtain when a disinfectant soap is used are very different from those of ordinary disinfecting. As a rule, the time of contact is much shorter, and the volume of water or vehicle much less.

As the time of contact is short, so it is necessary that the percentage of active ingredient should be high. As the volume of water used per unit weight of disinfectant soap is usually much less than is recommended when a liquid disinfectant is employed, this will assure a higher percentage strength of the active ingredient if it is present in the soaps in anything like reasonable proportions. On the other hand, it is important to note that, unless the disinfectant employed is readily soluble in water, actual contact of the infected parts with the disinfectant cannot be attained in the limited time given to washing.

ADVANTAGES OF DISINFECTANT SOAP.

The chief advantage of soap in this connection lies in its detergent action, whereby it is enabled to carry away germ-laden material and to saponify the oils and waxes, generally containing much inactive matter, which are given off by the skin.

Disinfectant soaps for toilet purposes should be made with the best materials according to the boiling and milling processes. Addition of antiseptics and disinfectants should be made carefully with a view to causing no irritation or injury to the skin.

CHIEF DISINFECTANTS.

The principal disinfectants used are limited in number, and include wood tar, coal tar, iodine; tar oil; phenols and cresols; mercuric chlorides; sulphur; etc. The various essential oils which are employed in perfuming toilet soaps have often a very pronounced disinfectant action, notable amongst them being turpine, almond and lavender oils.

CARBOLIC SOAPS.

Carbolic soaps were among the earliest disinfecting soaps. Crude carbolic acid was used to the extent of 10 to 15 per cent. In modern soaps of this type, this has been largely replaced by smaller amounts of pure phenols or cresols. Carbolic soap used for toilet purposes should not contain more than 3 per cent. of phenols in order to avoid the possibility of skin irritation, but household soaps can contain 5 per cent. In no case where the soap is to be handled should this proportion be exceeded, otherwise there may be corrosive action on the skin. The volatility of phenol is to be considered during storage, because it will gradually evaporate off unless suitably wrapped.

Cheap Carbolic Soaps.

The following recipe shows the constituents of a cheap carbolic soap for general cleansing and deodorising purposes:—

Tallow	15	lbs.
Rosin	15	,,
Liquid carbolic acid	2½	,,
Caustic soda lye 37°Be	15	,,

PROCEDURE:—Melt the rosin and tallow together and when the temperature is about 25°C. stir in the carbolic acid. Then gradually add the caustic soda lye with stirring. Heat until the reaction is complete. After saponification run the soap into frame and cool. Then cut into blocks of usual size.

Cold Process Carbolic Soaps.

For toilet purposes cold or rosin boiled soap is used, which retains glycerine liberated from fat. A recipe follows:—

Coconut oil	8	lbs.
Tallow	4	,,
Caustic soda lye 38°Be	6	,,
Carbolic acid	5	oz.

PROCEDURE:—Melt the coconut oil and tallow together by gentle heat. Then raise the temperature of the mixture to 35°C and stir in the caustic soda lye. Continue stirring until the soap becomes sticky. Now dissolve the carbolic acid in a little water and crutch well into the soap. Perfume the soap if desired with a little olive oil, lavender or rosemary oil. Before the soap gets hard, cut into tablets and wrap in an air-tight package.

CRESOL SOAPS.

The cresols have even more powerful antiseptic action than the phenols, besides being less corrosive and poisonous to human beings. Although cresol is hardly soluble in water, it dissolves readily in potash soaps, the resulting mixture being then miscible in all proportions with water.

Lysol is the basis of lysol soap. The solution, however is chiefly used as a liquid disinfectant. A lysol substitute, consisting of a mixture of equal parts of cresol and Turkey red oil is water soluble and finds a large use in certain soaps, as the oil is said to have no irritant action on the skin, and it is claimed by some to be actually beneficial.

IODINE SOAPS.

The well-known antiseptic properties of iodine have resulted in many soap makers making use of it. Iodine has not a very active antiseptic action when in the form of its compounds. It is therefore employed as a solution in alcohol or potassium iodide. The iodine is not stable, however, when used thus, as may be seen from the fact that soaps change their colour from brown to a light yellow in course of a short time.

A better way of introducing iodine into soap stock is to add it in the form of a compound with an unsaturated acid, such as oleic acid.

A large number of so-called iodine soaps are prepared with potassium iodide, and are quite stable, although they are not really iodine soaps at all. They are generally made by adding 6 or 7 per cent. of potassium iodide dissolved in a small amount of hot water to the melted soap togehter with ½ per cent. sodium bisulphite.

SULPHUR SOAPS.

Sulphur has for a long time been recognised as a useful therapeutic in certain skin troubles, such as ache and psoriasis. Its action is due to a mild antiseptic effect whereby it helps the skin to shed the adhering superficial layer of sebaceous matter which prevents the proper functioning of the pores.

The best type of sulphur soap contains sulphur in its most readily oxidisable state to secure bactericidal effect. The finest form is colloidal sulphur, but sublimed sulphur is most generally employed.

The difficulty of getting the sulphur into the water-soluble form in which it is most effective may be overcome by using a combination of certain pine oils (terpenes) with alkali sulphides. The solution of the clear, brownish liquid in water gives a white emulsion with a slightly alkaline reaction. The odour rather resembles that of pine oils and the sulphide smell is almost imperceptible. It is non-irritant and is an invaluable ingredient of high-grade sulphur soaps. Ichthyol, ammonium ichthyol sulphonate, obtained by the distillation with sulphuric acid of certain bituminous minerals, is sometimes used to about 5 p.c. in certain sulphur soaps.

WOOD TAR SOAPS.

These are among the most widely used medicated soaps, being employed as bath soaps for skin eruptions, sore hands and ringworm.

The stock soap used may be a cold or boiled variety but it is best to employ a grained soap made from a mixture of coconut oil containing 25 to 50 per cent. of its weight of tallow.

The tar is acid and consequently absorbs alkali when added to the soap kettle. It is therefore usual in preparing tar soaps to first neutralise the tar with alkali before crutching it into the melted soap. In order to incorporate the tar, the requisite amount of soap is added to a steam jacketed crutcher and melted. The correct weight of tar is weighed out and added, and the mixing started and continued for a time being so as to make a uniform mixture. The incorporation of the tar by the crutching process into the melted soap involves no difficulty but it is obviously essential that the crutcher must be carefully cleaned before using for any other brand of soap.

The soap, after crutching, is poured into a frame and then cut into slabs. These are then milled and stamped in the usual way. The milling imparts a finish to the soap which is not obtainable in any other way. The finished soap should be of dark colour, smooth, with a glossy finish.

Typical recipes follow:—

From Soap Stock.

Mix 40 lbs. of yellow or brown soap stock with 5 lbs. of wood tar in the manner described above. Then cool, dry and mill. Take care not to over-dry the shavings, otherwise difficulties will occur in the plodder.

By Cold Process.

Tallow	271	parts.
Coconut oil	271	„
Soap scrap	180	„
Pine tar	73	„
Caustic soda lye 36°Be	340	„
Sodium silicate	36	„
Pearl ash lye 36°Be	9	„

Place the tallow, coconut oil and pine tar in a steam jacketted crutcher and heat to 180°F. Add the scrap soap and melt completely. Now run in the mixed lye, add sodium silicate. Crutch for 5 minutes, allow to stand for one hour, and crutch again until combination is complete. Now add the pearl ash solution and crutch until the soap becomes thick and smooth, then run out the mass into the soap frame and allow to cool.

COAL TAR SOAPS.

These soaps are made in precisely the same way as previously described under wood tar soaps, with the difference that coal tar is the disinfecting substance added. Such soaps in addition to phenol, contain cresol, and other homologues. The amount of phenols present must not exceed 3 p.c. in a toilet soap otherwise an irritating action on the skin may occur.

TAR SULPHUR SOAPS.

I.

A tar-sulphur soap finds considerable application in skin diseases. It is a brown soap prepared by dissolving 2 ℔s. of potassium sulphide in a small amount of water, and adding it to 20 ℔s. of yellow stock soap, together with 4 ℔s. of birch tar oil. The mass is milled several times until the soap is uniform.

II.

Melt 20 lbs. of coconut oil and mix in at 25°-30°C. 2 ℔s. of flowers of sulphur; next mix in rapidly 12 ℔s. of soap lye of 28°Be. When combination is effected add 4-8 oz. of rosemary oil, and finally stir in vigorously 8 lbs. of wood tar. Immediately frame the soap.

III.

Dissolve 2 ℔s. of potassium sulphide in as little water as possible and add to 20 ℔s. of yellow stock soap. Next add 4 ℔s. of birch tar oil and pass the mass several times through the milling machine until the ingredients are thoroughly mixed. The resultant is a brown soap.

The cheaper wood tar may be used instead of birch tar oil, but this does not make such a good soap.

MERCURY SOAPS.

The manufacture of a soap incorporating corrosive sublimate is not an easy matter, because the mercury compound reacts rapidly with the soap to produce complex, greenish, insoluble compounds. Some soaps are still made simply by mixing chloride of mercury dissolved in alcohol or in potassium iodide, with castile soap. These retain the activity of the sublimate.

The above process makes the soap contain an excess of free fatty acid which prevents the chloride from reacting with the soap, while according to another process the chloride is mixed with an alkaline casein solution, forming mercury albuminate.

Mercuric iodide is also largely used in some soaps, and is a very reliable antiseptic for this purpose. It is best added in the form of the soluble salt with potassium iodide. This is prepared by mixing 4 parts of mercuric iodide with 3 parts of potassium iodide and 2 parts of water, and incorporating the precipitated salt with the milled soap.

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CHAPTER XIV.

AGRICULTURAL INSECTICIDES AND FUNGICIDES.

PLANTS, like human beings and animals, in virtue of their living cellular constitution, are liable to be subjected with various sorts of disease. These diseases of plants are quite as well defined as those of animals, and a certain anology exists between them, and among the numerous causes we again find the same physical, chemical or parasitic elements, which generally co-operate to produce a disease.

There are various types of parasites, namely animal parasites, vegetable parasites, microbe parasites, etc.

ANIMAL PARASITES.

Animal parasites belong to the most diverse classes, but insects especially occasion the most frequent and perceptible damage. The insect originates in the egg and passes through different conditions, until after a greater or less length of time it becomes perfect, that is, capable of laying eggs to ensure its reproduction. The consequence of these intermediate conditions is called metamorphosis, and the different forms, are known as larvae; caterpillars; grubs; chrysales, etc. It is especially in the larvae form that the insect is most injurious, because it sometimes remains several years in that condition.

VEGETABLE PARASITES.

Vegetable parasites include fungi and certain phanerogams. The elements of reproduction of fungi are spores (name given to seeds of fungi). These spores develop when climatic conditions permitting their evolution are realised. The mycelium (this is the name given to the new-born parasite) can then expand, either in the interior or on the exterior of the plant. In both cases it lives at the expense of the cellular tissue, and in so doing produces characteristic diseases to plants.

MICROBE PARASITES.

In the case of a microbe parasite it is especially necessary to know what factors induce its development, which is closely connected with the composition of the cellular substance. Plants, however, suffer less from these than animals, because the reactions of vegetable plasma are acid, which are less favourable to their evolution than an alkaline medium.

DESTROYING PARASITES.

When a parasite is of appreciable size, and especially when it forms visible and accessible colonies, its suppression by catching gives immediate results. On a large scale the parasites may be induced to localise themselves in spots where their destruction is easy by the application of insecticides. Among the various insecticides the following are extensively used.

AGRICULTURAL INSECTICIDES.

An effective and easily manufactured insecticide is made by dissolving 2½ lbs. of best soft soap in boiling water, and making up the solution to 10 gallons, stirring all the time; this constitutes the stock solution, and may be diluted 50 per cent. or more according to the hardness of the water; the solution when ready for use must foam readily when stirred. A useful hint when using hard water as the dilutant, is to recommend a handful of common washing soda to every 10 gallons of water. The whole is then stirred well and is sprayed a little at a time on the leaves to act as an insecticide.

Poisonous preparations are used for killing leaf-eating insects, such as, caterpillars and beetles, which, owing to a protective skin, are not affected by the ordinary insecticide. An incredibly small amount of poison will kill large quantities of insects, but great care is necessary when spraying the plants and trees, otherwise the foliage will be burnt. When fruit trees and edible plants are sprayed, it is desirable to allow six days' time before the fruits are gathered for consumption after spraying. The poisons usually met with, are Paris green, lead arsenate, hellebore, tobacco and pyrethrum. An effective insecticide is made by using Paris green, paste or powder, with 1 oz. to 10 gallons of water; the solution should be kept well stirred whilst using it, and be applied with a fine light spray. As a wash for use against leaf-eating pests on fruit trees the following is recommended:—

½ ℔. of lead arsenate paste (20 per cent. arsenic oxide) in 10 gallons of water, applied as a fine spray. Lead arsenate is a deadly poison and should not be used on fruit or when vegetables are grown under shades.

BORDEAUX MIXTURES.

This is one of the most useful and effective fungicides for application to plants attacked with mildew or other fungus diseases. There are various formulas for making it, all of which are somewhat of varying degrees of strength. The following is a standard formula:—

Copper sulphate	6 chattacks 2 tolas.
Quicklime	6 chattacks 2 tolas.
Water	8 gallons.

PROCEDURE:—Copper sulphate is to be dissolved in half the water in an earthen or wooden vat by suspending in a gunny sacking just immersed; stone lime should be slowly slaked in another vessel, by adding a quantity of water little by little until the bubbling ceases, after which the rest of the water is added. The two solutions should then be mixed together by pouring one into the other and sprayed.

Test the mixture before using by immersing a blade of knife into it. If there be a deposit of copper, then it is not fit for use and more of lime is to be added.

BURGUNDY MIXTURE.

Copper sulphate	12 chattacks 4 tolas.
Washing soda	1 seer.
Water	8 gallons.

Procedure:—Make up exactly as in Bordeaux mixture using soda instead of lime.

BORDEAUX OR BURGUNDY MIXTURE WITH ROSIN.

Washing soda	2 chattacks 3 tolas.
Rosin	3 seers.
Water	1 seer 8 chattacks.

Procedure:—Boil the water, then add the soda. When dissolved add the rosin and boil for about half an hour, stirring continually. Add this, when cool, to Bordeaux or Burgundy mixture as prepared above.

The mixture gives very good results in the case of spraying plants when rain is frequent.

SELF-BOILED LIME SULPHUR.

Quick lime	10	chattacks.
Sulphur	10	,,
Water	8	gallons.

PROCEDURE:—Place the lime in a barrel and add enough water almost to cover it. As soon as slaking starts, add the sulphur. Stir continuously and add enough water to make a paste and prevent caking at the bottom. When the violent slaking is over, add more water, so as to cool it, as prolonged heating is injurious. Then dilute and strain through a sieve, when it is ready for use.

This fungicide is recommended for spraying plants whose leaves will be injured either by Bordeaux or Burgundy mixture. This preparation is perfectly harmless even to delicate plants.

It has valuable insecticidal properties as well.

LIME-SULPHUR INSECTICIDE WASHES.

The Canadian Government advises for the destruction of coccides a bouillic consisting of 18 ℔s. of slaked lime, 18 ℔s. of sulphur, and 5¼ oz. of blue vitriol in 10 gallons of water. For the same purpose there is used in California a bouillic compound of 6 ℔s. of slaked lime, 3 ℔s. of sulphur, and 2 ℔s. of common salt (the latter added at the moment it is to be used) in 10 gallons of waer. This bouillic also kills the woolly aphis.

WETTABLE SULPHUR SPRAY.

A U. S. formula gives 4 ℔s. of slaked lime, 8 ℔s. of sulphur and 1½ ℔s. of powdered lead arsenate to 50 gals. of water, with 1 ℔. calcium caseinate or 4 oz. of glue per 100 gallons as a spreader.

LIME WASH FOR FRUIT TREES.

(British Ministry of Agriculture formula). Best stone quicklime 10—15 ℔s, water 10 gallons. Slake the lime with a little water, add the rest of the water, with thorough stirring, and strain carefully into the spraying machine.

FORMALIN.

It is a strong disinfectant and is used for treating seeds of wheat, oat, barley, jowar, etc. The grains are thoroughly wetted by sprinkling the solution on them and turning them over, after which they are covered with damp gunny bags immersed in formalin solution for 2 hours and then spread on the floor to dry. It is prepared as follows:—

Formalin	1	oz.
Water	2	gallons.

AMMONIACAL COPPER FUNGICIDE.

This is a very useful fungicide, having the properties similar to those of Bordeaux mixture. It is prepared as follows:—

Copper sulphate	1½	ounces.
Carbonate of soda	1¾	,,
Strong ammonia solution	12	fl. ounces.
Water, enough to produce	12	gallons.

Procedure:—Dissolve the copper sulphate and soda separately, each in half a gallon of water, pour the soda into the copper solution and stir well. When the precipitate has settled, pour off the clear liquid; give the precipitate a second washing, and when again settled, pour off the supernatant clear liquid. Then introduce sufficient liquid ammonia to dissolve the precipitated copper carbonate in it. Care is taken during the incorporation of ammonia not to use any unnecessary excess of ammonia. To this, add water to make up 12 gallons, when the liquid is ready for use. This preparation is especially recommended for surface moulds.

2. P. C. COPPER SULPHATE SOLUTION.

This solution is employed as a wash for dormant trees and for treating seeds which may be contaminated by adherent fungus spores. This solution is also sprinkled on the grain which is well turned over and then spread out to dry.

Copper sulphate	1 tola.
Water	1 quart.

The solution should not be prepared in metallic vessel.

SULPHUR.

This is used for the destruction of mildews, whose mycelium is superficial and forms white spots on the surface of living leaves, fruits, etc. It is applied as a powder in the familiar form known as "flowers of sulphur," preferably when the affected leaves are damp. Various applianes are in use for blowing the powder on to the leaves, such as sulphur- sprayer, etc. Occasionally sulphur is mixed with water, and thus syringed over the plants.

POTASSIUM SULPHIDE.

This powerful and useful fungicide must be kept in well-corked bottles or air-tight vessels, as it rapidly decomposes when exposed to the atmosphere. Care must be taken to adjust the strength of the solution to the nature and hardiness of the plants under treatment; a quarter of an ounce to 1 gallon of water will generally answer for slight attacks, and 1 to 10 oz. in 10 gallons of water is considered strong enough to suit all requirements.

CORROSIVE SUBLIMATE.

For disinfecting seed, preserving books, dried specimens of plants, etc. nothing is better than a solution of corrosive sublimate. This is a powerful poison and kills bacteria, fungus spores, and similar organisms by contact. It may be used with good result in a water solution at a strength of about 1 oz. to 7 gallons of water.

CONDY'S FLUID.

This is a useful fungicide and is sometimes employed for sterilising soil, the latter being allowed to remain for a week after treatment before anything is planted or sown. The preparation should be about 1 oz. of the fluid to 1 gallon of water.

POTASSIUM PERMANGANATE.

A simple but effectual fungicide may be prepared by dissolving about 30 to 40 grains of permanganate of potash in a gallon of water. The solution resembles Condy's fluid, being of a pale rose colour, and may be used for herbaceous and bulbous plants.

NON-POISONING FRUIT SPRAY.

Di-glycol Laurate	5 quarts.
Pyrethrum extract	¾ pint.
Water	100 gallons.

ORANGE WORM SPRAY.

Potassium aluminium fluoride	50 ℔s.
Talc	45 ℔s.
Refined mineral oil (70 viscosity)	5 ℔s.

Use 1 ℔. per tree.

LIME SULPHUR SPRAY.

This is effective as a winter application. It may be prepared as follows:—

Lime	2 ℔s.
Sulphur	1½ ℔s.
Salt	1 ℔.
Water	4 gallons.

PROCEDURE:—Boil the lime and sulphur together in a little of the water, and when combined add the rest of the water and salt.

KEROSENE EMULSION.

Kerosene emulsion is the most simple and effective remedy against all insect pests. It kills insects when applied to their bodies. In raw state, kerosene oil injures the plants, so it should always be applied after being diluted with some other materials which would form an emulsion in mixture with the oil. It is specially valuable when delicate plants are attended to. It may be prepared thus:—

I.

Kerosene oil	2 gallons.
Fish oil soap (or 1 ℔. soft soap)	½ ℔.
Water	1 gallon.

Procedure:—Cut the soap into small pieces. Then dissolve the soap pieces in the water by boiling. Remove the vessel with its contents from the fire or extinguish the fire and immediately add to the kerosene oil. Next agitate the whole mixture violently while still hot with an ordinary butter churn used in this country. The emulsion should be ready after 5 or 6 minutes' agitation, when it would assume the consistency of cream. Dilute the emulsion with water before use. If fish oil soap or soft soap (potash soap) be not available, use ordinary bar soap.

II.

Kerosene oil	2	gallons.
Sour milk	1	gallon.

PROCEDURE:—Mix the oil and sour milk together and churn as in the former case. After 5 minutes' agitation, a change from a watery liquid to a thick buttery consistency takes place, which is thicker than that with the soap. Sweet milk may also be used for the sour milk after a little vinegar is added to it. The emulsion cannot be stored long. Hence prepare it when required.

For soft bodied insects and plant lice, one part of the emulsion is to be diluted with from 10 to 15 parts of water; for the spider and other plant mites, the same with an addition of 1 ounce of flowers of sulphur to a gallon. For scale insects, the larger plant bugs, larvae and beetles, it should be diluted with from 7 to 9 parts of water.

CHAPTER XV.

ANTISEPTICS.

ANTISEPTIC is an epithet of substances, agents, etc., that impede arrest, or prevent putrefaction. The principal antiseptics in common use are boroglyceride, corrosive sublimate, iodoform, boric acid, salicylic acid, glycerine, carbolic acid, alcohol, ether, amyl alcohol, etc. Most of these preparations are dealt with in chemistry; hence these are not included in this treatise so as to increase its volume.

The manufacture of antiseptics is of course a lucrative industry. But anyone cannot manufacture a highclass antiseptic. Only a competent pharmaceutical chemist with a thorough knowledge in practical bacteriology can do so. However, we are giving here some practical formulas and processes which can be tried by any one.

PREPARATION OF BOROGLYCERIDE.

Boroglyceride is an excellent agent for preserving milk, fruits, meat; anatomical preparations, etc. It is obtained by heating 92 parts of pure glycerine to 302°F and gradually adding 62 parts of finely pulverised boric acid, water vapour escapes during the operation. The manipulation of about 6 pounds requires a whole day, as on account of the viscosity of the melted mass it is difficult for the water vapour to escape. The process is completed when no more loss of weight takes place, and the preparation dissolves readily in water at ordinary temperature. The escaping water amounts to somewhat more than 1/3 of the substances used.

Boroglyceride, when cold, is solid brittle and transparent of a light yellow colour and lustrous fracture. It is readily soluble in water, only slightly soluble in cold and in 5 parts of alcohol at 122°F, but insoluble in ether or chloroform at ordinary temperature. A hot alcoholic solution of boroglyceride might be well adopted for impregnating cotton for surgical purposes.

CALCIUM AND SODIUM GLYCEROBORATES.

Both of these substances are readily soluble in liquid, odourless, and non-poisonous.

Calcium glyceroborate is obtained by heating together equal parts by weight of calcium borate and glycerine with constant agitation, until a drop taken from the vessel and placed upon a glass plate solidifies to a clear colourless pearl. The compound is then poured upon a metal plate where it solidifies. The pieces, still hot, are kept in a well-stoppered bottle.

Sodium glyceroborate is obtained in the same manner by heating together 100 parts of anhydrous borax and 150 parts of glycerine. These compounds possess analogous properties; they melt at about 302°F and are very hygroscopic. They deliquesce very rapidly when exposed to the air, absorbing their own weight of water. They dissolve in half their weight of alcohol or water. Both have powerful antiseptic properties even in a very diluted state. They deserve preferenc to carbolic acid on account of being soluble in water in all proportions and producing no effect injurious to health. They can be applied without inconvenience even to such sensitive organ as the eye. In surgery they may be used in place of phenol.

IODOFORM.

Bicarbonate of potash (pure)	10	parts.
Alcohol (90 per cent.)	25	,,
Distilled water	120	,,
Iodine (crystals)	10	,,

Procedure:—Put the iodine in a comparatively long-necked flask, add the bicarbonate of potash, distilled water and alcohol. Now fit a cork through which passes a long glass tube; heat on a water bath, not too quickly to about 176°F (80°C); and add after decoloration of the liquid, 25 parts of iodine; add 2 parts and afterwards 1 part of iodine, waiting with each addition till the liquid has lost its brown colour. If iodine should happen to be a little in excess, add cautiously some solution of potash until decolourised, which shows completion of the process. Now pour the liquid into a porcelain dish, cover and let stand for 24 hours, throw on a filter, and wash the iodoform with cold distilled water. The iodoform will then separate out. It is dried between folds of blotting paper and enclosed in well-stoppered bottles. Care should be taken during packing, otherwise the iodine may be spoilt.

PRESERVING ANIMAL SKINS.

I.

Boil until reduced to one-half, 125 parts of colocynths and 25 of aloes in 1500 of water, and strain while hot. Then stir 500 parts of brown rosin soap in 250 of soft soap with some water to a paste over a moderate fire, and mix it carefully with the first decoction, and 125 parts of glycerine and 40 of rapeseed oil over a moderate fire. After thorough mixing stir into the whole 50 parts of powdered naphthalene, rubbed up with 35 parts of oil of turpentine and 80 of carbolic acid, kept liquid by a sufficient addition of alcohol. The mass should be homogenous; if too thick, thin it with the addition of oil of turpentine.

II.

Sulphate of copper	1	part.
Alum	2	parts.

Procedure:—Mix the two ingredients; then stir the powder into a paste with water. The flesh side of the skin is brushed with this as quickly as possible, in order to prevent evaporation of the water. The paste forms insoluble combinations with the organic tissues.

PRESERVING STUFFED ANIMALS.

I.

Mix 2 parts of air-slaked lime, sifted through a fine sieve, and 1 part of sifted tobacco ashes, with ½ part of alum. Rub the mixture thoroughly over the flesh side of the skins to be stuffed.

II.

Pulverise and mix thoroughly 1 part of cobalt and 2 of alum, and rub the mixture thoroughly over the flesh side of the skin previously burnished with pine oil.

III.

Boil ½ part of alum and ¼ part of pulverised cobalt in 4 parts of water; strain the fluid and brush it over both sides of the skin. This is suitable for preserving skins of mammals.

PRESERVING BOOKS.

Corrosive sublimate	1	ounce.
Carbolic acid	1	ounce.
Methylated spirit	2	pints.

Apply with a soft brush.

CHAPTER XVI.

STERILISATION OF DRINKING WATER.

IT is generally admitted that a number of infectious diseases, especially cholera, typhoid fever and small-pox, are frequently contracted and spread by means of drinking-water containing the bacteria of these diseases, derived from the excreta or other discharges from persons suffering from them, or from the washing of their infected clothing. Hence it is important to sterilise the water before using especially during the time of epidemics.

METHOD OF SEDIMENTATION.

For the purification of drinking and domestic water, the most usual method is the sedimentation in large reservoirs followed by filtration. During the settling process there is an almost complete removal of suspended mineral matters, and with them a large proportion of living organisms, while oxidation of the dissolved organic matter takes place; unfortunately, the deposited bacteria continue to live and multiply in the muddy sediment, unless this is removed at frequent intervals, thereby necessitating regular periods for cleansing with additional reservoirs for the maintenance of the service.

SAND FILTERS.

For small house filters the usual filtering media are kieselguhr, asbestos, porous earthenware plates, spongy iron, coal, etc. On a large scale, however, the slow sand filtration process is still the most complete method for purifying surface water, and offers the greatest security for retaining infectious germs.

The action of sand filter depends on the formation of a slimy layer composed of finely divided clay, algae, etc. in which the main purification of the water takes place. Here a felted mass of bacilli are entangled in a gelatinous layer of the zoogloea colonies of micrococci together pith the algae, and a sand filter cannot attain its maximum efficiency until this jelly layer has been produced. When once formed the purification proceeds by the action of nitrifying organisms immediately below this film.

Filtration through sand, charcoal, or spongy iron has the effect of removing the whole of these bacteria, but unless the material of the filter is frequently renewed, this high state of efficiency is not maintained, and the filter may even serve as an incubating bed for these injurious bacteria so that the water passing through the filter is rendered worse by filtration.

STERILISATION BY BOILING.

Again, simply boiling the water for a few minutes does not entirely destroy the bacteria contained in it, but greatly diminishes their number. But the taste of boiled water is often objected to, as the liquid is thereby not only free from dissolved gases, but frequently produces a burnt flavour from overheated organic matter.

PURIFICATION BY OXIDISING AGENTS.

At present oxidising agents have found favour in purifying drinking water on the ground that oxygen is the natural purifier. It is obvious that for purifying drinking water only such re-agents must be employed which do not affect its wholesomeness or palatability. In water supplies, however, from which the greater part of organic matter has been removed by some preliminary process, the quantity of some oxidising agents required is so exceedingly small that it would have no injurious effect on the consumer. Among these substances the manganates and permanganates are very popular. These substances have a wide application in purifying wells and tanks.

PURIFICATION WITH HYPOCHLORITE & CHLORINE.

Besides manganates and permanganates, calcium hypochlorites and electrolytic chlorine are now used in considerable quantities in the sterilisation of drinking water. This method of purifying water has proved to a large extent its power of checking water-borne typhoid epidemics, and it may be stated that while filtration alone may remove 97-98 per cent. of the bacterial contamination, the hypochlorite treatment, in conjunction with filtration, removes 99.9 per cent. i.e., the chlorination kills the bacteria which the filtration has left.

Since there are now so many appliances by which the ratio of sterilising agent to the volume of the water pumped from the river can be automatically adjusted, there is no reason why any excess of chlorine should ever be found in a public supply.

Although it is amazing to what extent water can be sterilised by well-conducted slow sand filtration, which fulfils the double purpose of clarifying the water and freeing it from the greater part of the microbes it contains, yet hygienists are still demanding greater purity than the filters are usually able to supply. The methods described above possess more or less disinfecting properties but the more recent hypochlorite and chlorine processes should be further improved in face of a certain amount of aversion by the public to the idea that anything more should be added to drinking water.

STERILISATION OF WATER BY ULTRA-VIOLET RAYS.

The latest process proposed for the sterilisation of water is that of using ultra-violet rays. Although this process is new, it is in reality the oldest, having existed in nature since the beginning of time; for sunlight, which is one of the powerful bactericidal agents known, accomplishes the larger part of the natural purification of water.

There are many types of ultra-violet ray sterilisers but the R. U. V. striliser is commonly used in foreign countries. In this apparatus the water under treatment is made to flow past a source of ultra-violet rays. A number of baffle plates are arranged in such a way as to make the water pass several times under the influence of rays, therefore ensuring complete obstruction of the microbes.

In concluding it should be noted that various classes of microbes are not all equally sensitive to the ultra-violet light, just they are not equally sensitive to heat or chemical agents.

CHAPTER XVII.

MEDICATED GAUZES.

IN manufacturing medicated gauzes which have wide uses, the gauze employed should be of soft-texture, and contain about sixty threads to the linear inch; it requires purification by some process similar to the following: 100 parts of gauze are soaked for several hours in warm water, then wrung out and boiled for several hours in water containing soap and common washing soda. The gauze is then well washed in clean water and soaked for several hours in dilute chlorinated lime solution; it is again washed, soaked in dilute hydrochloric acid, and washed in running water until every trace of chlorine or acid is removed; it is then dried in a drying closet.

To medicate the gauze either an atomiser is used to spray a solution of the medicament upon it or the gauze is immersed in the solution and squeezed until only a sufficient liquid is retained to correspond with a definite percentage of the active ingredient. The wet material is then laid on nets and turned over from time to time to ensure even distribution of the liquid during drying.

CARBOLIC GAUZE, TEN PER CENT.

Castor oil	5	parts by weight.
Rosin	48	,, ,,
Phenol	12	,, ,,
Alcohol, 90 p.c.	85	,, ,,
Gauze	90	,, ,,

PROCEDURE:—Dissolve the first four and in the solution impregnate 90 parts of purified gauze and press slowly and weigh. Repeat pressing and weighing until the actual weight of the impregnated gauze becomes 215 parts; finally dry in a drying closet. In any case it should not be exposed to the air as some dust and dirt will fall on it, which is highly objectionable to this antiseptic preparation.

SALICYLIC GAUZE, TEN PER CENT.

Salicylic acid	12	parts by weight.
Alcohol, 90 p.c.	60	,, ,,
Distilled water	70	,, ,,
Gauze	90	,, ,,

PROCEDURE:—Dissolve, impregnate 90 parts by weight of purified gauze in the mixture, and press as before until the weight is 215 parts; dry. If desired, a gauze of the same type as carbolic can be prepared, using an equivalent quantity of oil, rosin and alcoholic mixture in place of the mixture of alcohol and water.

BORIC ACID GAUZE, TEN PER CENT.

Boric acid	12	parts by	weight.
Distilled water (hot)	138	,,	,,
Gauze	90	,,	,,

PROCEDURE:—Dissolve the boric acid in hot water and impregnate the purified gauze, then press it to obtain 215 parts, and finally dry.

THYMOL GAUZE, TWO PER CNT.

Thymol	3	parts by	weight.
Rosin	5	,,	,,
Spermaceti	50	,,	,,
Alcohol, 90 p.c.	50	,,	,,
Purified gauze	90	,,	,,

PROCEDURE:—Moisten the gauze with the solution, place in a hot press, squeeze, two or three times, to distribute the medicament and dry.

IODISED GAUZE, TEN PER CENT.

Purified gauze 90 parts by weight.

Place in a wide-mouthed stoppered bottle, and heat to 100°C. Then take of

Iodine 10 parts by weight.

Wrap in blotting paper, and drop into the jar, heat until the gauze is uniformly impregnated.

IODOFORM GAUZE, TEN PER CENT.

Iodoform	10	parts	by weight.
Methylated ether	70	"	"
Purified gauze	90	"	"

PROCEDURE:—Dissolve the iodoform in the ether, moisten the gauze, wrap in paper, press quickly, and dry in the dark away from lights or fires.

CHAPTER III

MEDICATED COTTONS.

COTTON in various forms has become an absolute necessity now-a-days in the medical profession. Besides pure cotton wool used in surgery we have now a considerable number of ingenious preparations in which the pure cotton is impregnated with a variety of drug solutions and afterwards drying, in order to render it a valuable agent in the dressing of wounds, in painful swellings or indurations, and for a number of external applications. When the medicinal substance is truly soluble in water, a solution of definite strength is prepared first, and the material allowed to soak in it until thoroughly saturated. It is then withdrawn from the solution and squeezed until only sufficient liquid is left to correspond with a definite percentage of the active ingredient. The wet material is then placed on nets and turned over from time to time to ensure even distribution of the liquid during drying. When the active ingredient is poisonous, as mercuric chloride, it is customary to colour the solution with aniline blue, thereby indicating about the poisonous nature of the preparation.

For the medication of cottons, etc., with iodoform, iodol, etc. their solutions are prepared in a mixture of alcohol and ether. The solutions are poured into the centre of the material, which is then quickly rolled up into a ball and submitted to hydraulic pressure for a few minutes. It is then taken out of the press, shaken slightly, rolled up, and again pressed. By this means a small quantity of liquid can be made to damp a comparatively large bulk of absorbent material.

Now let us come to the preparation of absorbent cotton wool which is the basis of all other medicated cottons.

ABSORBENT COTTON WOOL.

Absorbent cotton is obtained from the hairs of the seed from one or more of the cultivated varieties of *Gossypium* freed from adhering impurities and linters and deprived of fatty matter. Purified cotton wool is cellulose in one of its purest forms. Cotton wool is prepared by macerating the commercial article for a space of 10 minutes in benzol; pressing out the liquid and allowing the cotton wool to dry by exposure to the air. Another method is to macerate the cotton in a warm weak solution of soda, then to rinse it in a weak solution of chlorinated lime to whiten it and to wash well with water; finally, the substance is dipped into a very dilute solution of hydrochloric acid and washed with water until neutral. The cotton is next thoroughly dried in the air and carded or combed. This treatment has for its object to remove any grease or fatty matters which may be present in the samples and thereby enables them to absorb the medicating substances more easily. Many greasy samples of cotton wool will not mix with watery liquids at all, and cotton which is impregnated with oils or resinous substances absorbs the active ingredients irregularly, yielding a preparation which is far from uniform in quality.

Another method of purifying cotton is to boil with a 5 per cent. slution of chemically pure caustic soda or potash for half an hour.

It is then thoroughly washed and all water is pressed out as far as possible and then immersed in a 5 per cent. solution of chloride of lime (bleaching powder) for 15 to 20 minutes; washed with a little water, then with water acidulated with hydrochloric acid and then again with clean water.

The purified cotton is next tested in the manner described below. After testing it is dried in hot air chambers, broken in openers and medicaments are added and after passing through wadding cards rolled, cut and dried ready to be packed.

As cotton wool is a most important article of surgery, its purity is absolutely necessary. We must, therefore, go on with a number of simple processes by which we may be able to detect the presence of impurities in it. The following methods are generally suitable:—

(1) When the purified cotton, previously compressed by the hand, is thrown on the surface of cold water, it readily absorbs the latter and sinks.

(2) Burn 5 grams. of purified cotton; not more than 0·2 per cent. of ash remains.

(3) Thoroughly saturate about 10 parts of purified cotton with 100 parts of distilled water, then with the aid of a glass rod press out two portions of the water, 25 parts each, into white porcelain dishes. Add to one portion 3 drops of phenolphathalein and to the other portion one drop of methyl orange. If no pink colour develops in either portions, this indicates that the cotton wool is free from alkali or acid.

(4) To detect the presence of fatty matters extract 5 grms. of purified cotton, tightly packed in a narrow percolator with ether, until the percolate measures 20 millilitres, and evaporate this to dryness; the residue does not exceed 0·6 per cent.

IODISED COTTON.

The iodised cotton is prepared by thoroughly drying 375 grains of pure cotton wool in a stove; then mixing with it 30 grains of iodine, and placing the mixture in a closed flask at a temperature of 212°F (100°C) for an hour; this is effected by placing the flask upon a water bath. The iodine is thus equally diffused throughout the cotton. This preparation, we are assured, acts as a useful revulsive in neuralgia, serious effusions, slight inflammation of the respiratory organs, etc. A modern French work as well as the U. S. A. Pharmacy gives the following instruction:

Iodine	1	part.
Purified Cotton wool	12	parts.

PROCEDURE:—Enclose the iodine in some filter-paper and place it at the bottom of a flask with wide mouth; then introduce the cotton wool and close the flask by covering the mouth. Place the flask in a moderately warm place until the cotton appears to be uniformly coloured by the iodine. The preparation must be kept in stoppered bottles with wide mouth placed in a cool dark place.

SALICYLATED COTTON.

This preparation consists of purified cotton wool impregnated with about 4 to 10 per cent. of salicylic acid, and the same quantity of glycerine to make it adhere. It has been found useful as an antiseptic agent in the dressing of wounds. In cases of amputation it is asserted that the patient has been kept without fever by the use of salicylated cotton wool dressing which is only required to be renewed at the end of the week. The formula for its preparation is as follows:—

Purified cotton wool	100	parts.
Salicylic Acid	10	,,
Rectified spirit	100	,,
Glycerine	10	,,

PROCEDURE:—Dissolve the salicylic acid in the rectified spirit; add the glycerine to the solution; saturate the cotton wool with the liquid; press out the superfluous liquid; dry with the usual precautions; and keep in wide-mouthed bottles.

BORIC COTTON.

To prepare this important antiseptic material the ingredients are taken in the following proportions:—

Purified cotton		q.s.
Boric acid	40	grains.
Distilled water	9	fl. drams.

PROCEDURE:—Dissolve the boric acid in the distilled water at a temperature of 140°F (60°C). Saturate the purified cotton wool with this solution; then press, dry, and preserve it in corked bottles having a wide mouth.

COTTON WITH BORIC ACID, 10 PER CENT.

Boric acid	12	parts by	weight.
Boiling distilled water	138	,,	,,
Asorbent cotton	90	,,	,,

PROCEDURE:—Dissolve the boric acid in the boiling water and soak the cotton in the solution and squeeze until it weighs 215 parts; dry in a closet.

IODOFORM COTTON.

This preparation has come into extensive use during recent years. It is best made in the following manner. It is necessary that each ingredient must be taken very accurately according to the proportion given:—

Iodoform	1	part.
Methylated ether	10	parts.
Purified cotton wool	10	,,

PROCEDURE:—Dissolve the iodoform in the ether and saturate the cotton wool with the liquid. Let it dry by exposure to the air. Draw the cotton out and keep it in glass stoppered bottles with a wide mouth, closing well, place in a dark cool place.

COTTON WITH IODOFORM, 10 PER CENT.

Iodoform	10	parts by	weight.
Methylated ether	70	..	..
Absorbent cotton	90	..	..

Procedure:—Dissolve the iodoform in the ether and distribute evenly through the cotton, press quickly, and spread out to dry away from naked lights or fires, and keep it in a dark place.

GLYCERINATED COTTON.

This preparation is recommended by Gubler. It consists simply of pure cotton tissue permeated with pure glycerine; and it is said that cotton so prepared is permeable to all medicinal liquids without losing either its suppleness or its tightness. It is obtained by pouring a few drops of pure glycerine upon squares of cotton, and then squeezing them as strongly as possible with the hands.

HAEMOSTATIC COTTON.

To prepare haemostatic cotton the purified cotton wool is boiled in a solution of soda, and then plunged into a solution of perchloride of iron. It was invented by the German Pharmacist, K. Ehrle, and has been employed on the Continent both for hospital and camp use. It is used like lint.

SAL ALEMBROTH COTTON.

Sal alembroth	2.4	parts	by weight.
Aniline blue (water soluble)	0.05	”	”
Distilled water	150.0	”	”
Absorbent cotton	100.0	”	”

PROCEDURE:—Dissolve, soak the cotton in the solution until evenly wetted, and squeeze until it weighs 225 parts; dry. This is commonly known as “blue wool.”

Another method of preparing this cotton is to saturate 100 parts of purified cotton wool with 2 per cent. sal alembroth dissolved in water tinted with aniline blue.

AMMONIACAL COTTON.

This product was described by Mr. B. Brown, who observed that when ammonia gas is passed through pure, dry cotton wool it is absorbed to a very large amount. In a water bath, exposed to the air, the preparation loses all its ammonia.

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